Environmental Controls in IDD: A Case Study in the Xinjiang Province of China

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Environmental Controls in IDD: A Case Study in the Xinjiang Province of China

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Weight and height measurement of school children in the Wushi study area prior to thyroid examination.

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The link between iodine deficiency and the onset of health problems such as goitre, growth impairment, mental retardation and cretinism (iodine deficiency disorders, IDD) has been known since 1895. The WHO currently estimate that 1 billion people in the world today are at risk from IDD which make those affected less able to work and create wealth. People at risk are often the poorest members of the population who are totally dependent on subsistence agriculture for their dietary needs. The inability of their local environment to provide the correct mineral balance can lead to serious health problems.

Although many successful remediation programmes involve dietary interventions such as the provision of iodised salt and iodised oil, they can be difficult to implement in regions where these prophylaxes are not acceptable to the local population. Furthermore, these techniques do not address the underlying issue of environmental iodine deficiency and it may be more beneficial and sustainable to improve the iodine content of natural food intake.

In many medically driven studies carried out to date, the iodine deficient state of the population has been superimposed on the local environment without examining the parameters that control the distribution and uptake of iodine into the food chain via the soil-crop-animal-water-human interface. In Xinjiang Province, north-west China a new approach based on adding iodine (iodine dripping) to irrigation water had been tested by previous investigators and the present study had the opportunity to examine environmental iodine and impacts on health in three contrasting areas:

Area 1 – AC148, low (3.5%) recent goitre prevalence (20% historic rate); no iodine irrigation; iodised salt available

Area 2 – Kuqa District, > 30% goitre prevalence rate, no iodine irrigation; iodised oil programme implemented

Area 3 – Wushi District, 40 – 60% goitre prevalence rate; iodine irrigation; iodised oil programme implemented

Results from 5 soil and wheat; 3 cabbage and 1 drinking water samples collected in 5 villages in each of the three study areas show that total iodine concentrations in soils are similar in all three areas (AC148 range 0.3 – 3.9, median 1.05 µg/g; Kuqa range 0.3 – 2.93, median 1.0 µg/g and Wushi range 0.3 – 1.73, median 0.84 µg/g) and are low by world standards. Soil water- soluble iodine contents are also very low (range 0.012 – 0.040 µg/l, median 0.012 µg/l) in all three study-areas. The total iodine content of wheat in the three study areas is broadly similar (AC148 5.66 – 31.40, Kuqa 3.17 – 38.87 and Wushi 5.12 – 36.25 µg/100g) and is comparable to other areas of the world. Cabbage iodine contents also show little variation between the three study areas (AC148 5.86 – 16.19, Kuqa 3.55 – 23.46 and Wushi 6.42 – 21.22 µg/100g) but are marginally lower than results from elsewhere. Cabbage may be more sensitive to differences in soil iodine levels than wheat because uptake into plants is controlled by iodine volatilisation from the soil and deposition onto leaves rather than root transfer into the grain-head.

Previous investigators reported significant (ten-fold) initial increases in soil water-soluble iodine contents following the Wushi iodine-dripping programme carried out in 1999. The results of the present study, carried out in 2000 show that over the longer term, there is little evidence that that the dripping programme has increased soil or crop iodine levels beyond the natural contents of the non-dripped areas.

These findings are also in contrast to supposition from southern Xinjiang Province, suggesting that iodine in irrigation water may be effective up to 6 years after application. The reason for this disparity in results may be due to differences in methodology adopted by the two studies and may also reflect differences in soil type between the Wushi area and southern Xinjiang.

In many soils, the main source of iodine is from marine volatilisation and atmospheric deposition. The ability of a soil to retain iodine and the transfer of iodine from the soil to the food chain via plants is dependent on geochemical parameters such as the organic matter and clay content and pH conditions. Acidic soils favour, whereas alkaline oxidising conditions inhibit the bioavailablity of iodine. This undoubtedly explains the very low iodine status of the study areas, which lie in a continental interior, alkaline desert environment. Soils in the Wushi and Kuqa study areas are more alkaline and have lower clay content than soils in AC148, which may in part explain the greater problems with iodine deficiency in these areas.

Although soil and crop iodine concentrations are similar in the three study regions, the surface- and shallow ground- waters used for drinking in Kuqa and Wushi Districts have very low iodine contents (0.1 – 4.05 µg/l) whereas waters abstracted from deep boreholes in the AC148 area contain very high quantities of iodine (78 – 100 µg/l). It is clear that drinking water in AC148 has a significant impact on the diet, (wheat, cabbage and water iodine intake 320 µg/day) compared with recommended daily levels (150 – 300 µg/day). In contrast, dietary intakes from wheat, cabbage and water in the Kuqa and

Wushi study areas are low (139 and 124 µg/day respectively). The eradication of goitre from the AC148 region may have much to do with the development of the area and provision of centralised groundwater supplies rather than iodised salt.

The importance of iodine in drinking water to the diet is often ignored because in many western countries this source is very minor compared to food. However, the results of this study confirm previous investigations and demonstrate that in subsistence populations consuming low-iodine foodstuffs, water can be an important dietary contributor if supplied from deep groundwater resources, which generally contain much higher concentrations of iodine than surface waters. Thus in some situations, the provision of deep groundwaters for drinking may prove another useful environmental intervention technique in IDD and may happen inadvertently as groundwater resources are often supplied in developing country situations to avoid bacterially contaminated surface waters.

During the present study, the iodine status of the population was determined using ultrasound thyroid volume, age, height, weight, sex and $2^{nd}/4^{th}$ finger ratios on 119 school children in AC148 and 300 children in each of Kuqa and Wushi and by TSH, T4, urinary iodine and fluoride measurements on a sub-set of 50 children in each region. The ultrasound thyroid volume method is more reliable than the hand palpation techniques deployed by previous surveys carried out in the study region.

Results show that the thyroid volumes are low (0.1 – 7.09 mls) by all standards even taking into account the smaller size of the children studied compared to Western counterparts. The results reflect the adequate natural intake (mainly from water) and salt iodination programmes in AC148 and the recent iodination initiatives in Kuqa and Wushi demonstrating the success of these programmes.

Indicators including body surface area against age and the $2^{nd}/4^{th}$ finger ratios show that nutritional status decreases from AC148 to Wushi in line with the historic goitre prevalence and reflects the fact that AC148 is the most developed and Wushi the least developed region.

Thyroid volume and TSH results (mean TSH AC148 1.79 mlU/l; Kuqa 1.31 mlU/l and Wushi 1.17 mlU/l) reflect the historic goitre picture and nutritional trends and are highest in Wushi and lowest in the AC148 study area demonstrating the sensitivity of these techniques and the underlying differences between the three areas despite the iodination programmes.

Village mean T4 hormone results (36.14 – 47.60 nmol/l) are higher than the threshold for endemic cretinism (3.22 nmol/l) indicating that although reported historically, this is unlikely to be a problem in the region.

Urinary iodine results show a marked contrast between AC148 (mean 464 µg/l) and the other two regions (means Kuqa 245 µg/l and Wushi 324 µg/l) and reflect the much higher intake of iodine in drinking water in the AC148 area. 6%, 44% and 14% of the children studied had urinary iodine levels below the recommended threshold indicative of adequate dietary intake (100 µg/l) in AC148, Kuqa and Wushi respectively. The variation in results is likely to reflect differences in access to iodised salt and the efficacy of the oil iodination programmes rather than impacts from iodine-irrigation. The results demonstrate that despite iodination programmes in Wushi and Kuqa, significant proportions of the population may still be at risk from iodine deficiency.

In contrast, results for urinary iodine also show that 76%, 34% and 56% of the children examined in AC148, Kuqa and Wushi respectively have levels that exceed the recommended upper threshold indicative of dietary intake (300 µg/l). This calls into question the need for iodised salt provision in the AC148 area in light of the high iodine intakes from drinking water and highlights the potential toxicity problems of blanket oil iodination programmes.

Although the results of this study show that the iodination programmes carried out in northern Xinjiang Province have been successful and no incidents of goitre were evident, the population is still at risk from an iodine deficient environment and without the prospect of rapid economic and social development will remain so into the future requiring on-going supplementation.

Whereas iodised oil, iodised salt and water-based iodine releasers address inadequacies directly in the human population, they do not impact upon the broader environmental deficiency. Consideration of the wider environmental issues is important because increases in the iodine content of soils and plants also improve crop and animal productivity and can therefore enhance the general economic and nutritional well being of communities contributing to sustainable development.

Therefore, although the results of this study suggest that the iodine added in irrigation waters is only active for 1 or 2 years it is still a very cost effective method (1 Yuan per person per year) to increase environmental levels. In order to maximise the benefits of this technique, it is recommended that agricultural practices to enhance the retention of soil iodine should be considered and factors that will strongly fix the iodine in the soil and make it unavailable for uptake to crops should be restricted. In Xinjiang, such methods could include the addition of organic matter, for example, ploughing back straw and manure, to the soils to help retain the iodine. It is also recommended that the long-term fate of soil iodine added by the irrigation programmes be investigated more fully.

Further investigations into the costs of iodine supplementation programmes are recommended. Such studies should take account of benefits other than monetary issues such as the effects of additional iodine on animal and crop productivity, the antibacterial effect of iodine when added to water or other environmental components and possible toxicity in the human and animal population.

1 Introduction

The British Geological Survey (BGS) is currently investigating factors in the environment that control the distribution and prevalence of iodine deficiency disorders (IDD). This report is an account of field investigations carried out in the Xinjiang Province of China in October 2000 in collaboration with the Institute of Rock and Mineral Analysis (IRMA), Beijing. Dr Alex Stewart, Merseyside and Cheshire Public Health Department (UK) and the Xinjiang Endemic Disease Research Institute (EDI), Urumqi, China provided the medical contribution to the project. This study forms part of a British Government Department for International Development (DFID) Knowledge and Research (KAR) project (7411).

This account seeks to:

- outline the objectives of the case study
- report the methods used
- present the results of the case study

This report will be used along with other case studies and literature reviews to formulate a strategy for the management of environmental iodine to help in reduce the prevalence of IDD.

The geochemistry of iodine and the causes and description of IDD will be described in later reports and will not be discussed further here.

1.1 BACKGROUND

Plants, humans and other animals require small doses of several naturally occurring trace elements and minerals to maintain health. Elements can be assimilated by humans via several pathways including the food chain, drinking water and the inhalation and ingestion of particles from the atmosphere. Animals and plants in the food chain ultimately depend upon soil, water and rock in the environment for the provision of essential minerals. This link between the environment and the food chain is particularly important in developing countries where people are often totally dependent on subsistence agriculture for their dietary needs. The inability of the local environment to provide the correct mineral balance can therefore lead to serious health problems and disease.

In humans and other animals, iodine (I) is essential to health and forms an important constituent of the thyroid hormones thyroxine (T4, also known as tetraiodothyronine) and triiodothyronine (T3). These hormones play a fundamental biological role controlling growth and development (Hetzel and Maberly, 1986).

If the amount of utilisable iodine reaching the thyroid gland is inadequate, or if the thyroid gland is not functioning, as it should, then hormone production is reduced and results in a group of conditions in man, referred to as Iodine Deficiency Disorders (IDD). The best-known form of IDD is goitre, which is an enlargement of the thyroid gland in an attempt to make more efficient use of the inadequate levels of iodine available. Goitres can vary in size, from small nodular to monstrous. In more extreme cases, IDD include cretinism, mental retardation, deafness and retarded growth. One of the earliest investigations to confirm the link between endemic goitre and iodine deficiency was the work of (Marine and Kimball, 1920) who showed dietary iodide supplementation dramatically reduced the prevalence of goitre among school children in Ohio, USA.

IDD have been recorded in many areas of the world including South America (Ecuador, Peru, Bolivia, and Argentina), Africa (Zaire), Asia (India, Pakistan, Nepal, Bangladesh, China, Indonesia, Vietnam and Papua New Guinea) and historically in northern Italy, Switzerland, the UK and in Ohio in the USA. Extensive dietary supplementation programmes in may areas of the world including China, the USA, Switzerland, Papua New Guinea and India have proved successful in lowering the prevalence of cretinism and goitre. These programmes have generally involved the addition of iodised oil or iodised salt to the diet. Despite the success of these programmes, endemic IDD still occur in many areas of the world. The World Health Organisation (WHO) estimate that at least one billion people are at risk from IDD in the world today.

During the current study, in China the project had a unique opportunity to work in a region where an experimental environmental approach to tackling the risks of IDD had been applied by previous workers. Iodine was added to irrigation water at various locations in Xinjiang Province in the northwest of China since 1992 by the Xinjiang Uiger Autonomous Region Iodine Dripping Project (XIDP) (Shaohua and DeLong, 2000), (Cao et al., 1994), (DeLong et al., 1997) and (Jiang et al., 1997). The west of Xinjiang Province is an area of severe iodine deficiency with an associated high infant-mortality rate. According to the 1995 national IDD survey, the goitre prevalence rate among school children aged 8 to 10 was 43.3%, the highest in China (Shaohua and DeLong, 2000). In some parts of the province the usual method of iodine supplementation based on universal salt iodination has significantly reduced the prevalence rate of endemic goitre such that the 1997 survey showed a decrease to 22.1% goitre prevalence among school children aged 8 to 10 years old (Shaohua and DeLong, 2000). Xinjiang Province is located in the northwest of China and shares a border with Mongolia in the northeast and Kazakhstan in the northwest (Figure 1.1). The mean annual precipitation in western Xinjiang is less than 100 mm per annum and the climate is semi-arid continental interior with low humidity. Surface water run-off from the surrounding Kunlun, Pamir and Tien Shan Mountains is used for irrigation in this rural relatively undeveloped region. (Plate 1.1). Water drains into the Taklimakan Desert basin where it evaporates in the arid climate (Plate 1.2). Here rock salt with negligible levels of iodine (0.2 µg/g) is the traditional source of salt and this is the reason why intervention with iodised salt has not been wholly successful (Cao et al., 1994). Rock salt is also mined from the sediments forming the foothills of the Tien Shan Mountains (Plate 1.3).

The objectives of the XIDP (funded by Kiwanis International) are summarised by (Shaohua and DeLong, 2000):

- *to introduce iodine dripping to the highest iodine deficiency prevalence areas in Xinjiang*
- *increase urinary iodine content of women of reproductive age in the project area to 50 µg/l*
- *improve the infant development indicators*
- *reduce the prevalence rate of endemic goitre and cretinism*
- *increase live births of sheep and other livestock, thus resulting in increased profits from animal husbandry.*

Initial iodination of irrigation water commenced in 1992 in Hotan County (DeLong et al., 1997). The work has been extended and during the period 1997 – 1999, 13.25 tons of potassium iodate were dripped in 16 districts, 168 townships in Hotan, Kashi and Aksu counties covering some 454,000 hectares of irrigated land (Shaohua and DeLong, 2000) (Plate 1.4).

1.2 OBJECTIVES

The objectives of the current study were to investigate the environmental iodine distribution in areas of Xinjiang Province and relate this to the current and historical IDD status of the local population. Three contrasting areas were selected for this study and their locations are shown on Figure 1.1. These areas can be described as follows:

Area 1 - Agricultural Commune 148 (Shihezi County). An area of historically high goitre prevalence (20%) where currently a low rate of IDD (3.5%) is reported. It lies outside the area of iodine dripping projects but iodised salt has been available to the local population for the last 15 years.

Area 2 - Kuqa District (Aksu County). An area of high goitre prevalence (> 30%) where no iodine has been added to the irrigation water but iodised oil programmes have been implemented.

Area 3 - Wushi District (Aksu County). An area of high goitre prevalence (40 – 60%) where iodine has been added to the irrigation water and iodised oil programmes have been implemented.

Through a study of these three areas (summarised in Table 1.1) the project seeks to achieve the following aims:

(a) To disseminate data and information about environmental iodine status, particularly that relevant to the effectiveness of environmental intervention techniques

(b) Compare and contrast areas of historically high IDD where water iodination has, and has not, been applied

(c) Investigate iodine migration from the environment through the food chain to the local population

(d) Study the input/output balance of natural and added iodine in an iodine-dripped irrigation area

(e) Study the soil characteristics responsible for fixing iodine in soils

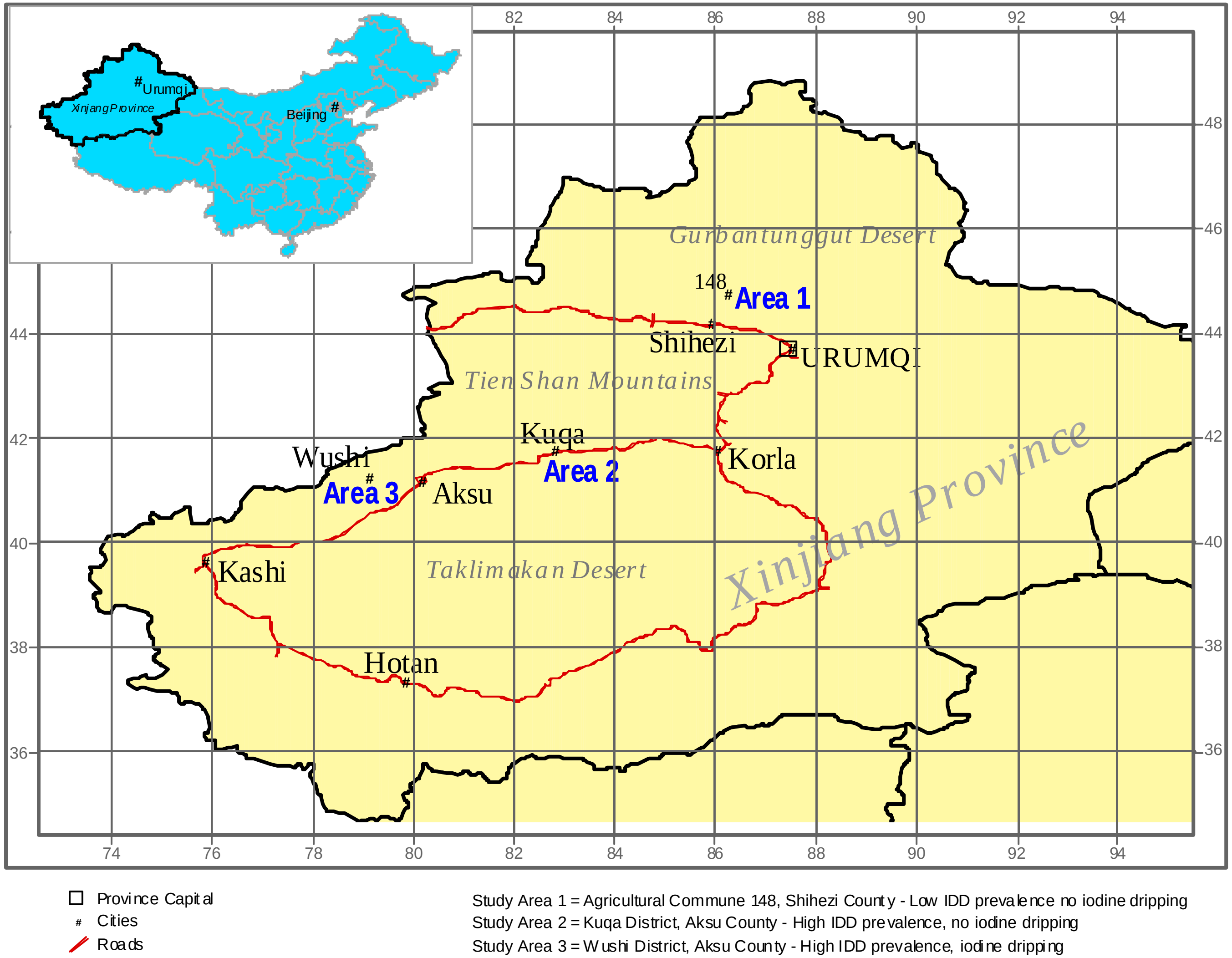
(f) Independently verify the effectiveness of the supplementation project in an iodine-dripped irrigation area.

TABLE 1.1 PRINCIPLE IDD CHARACTERISTICS OF THE THREE STUDY AREAS

Area Code	Study Area	High Prevalence IDD	Iodine added to irrigation water
1	Agricultural Commune 148	x*	x
2	Kuqa District	✓	x
3	Wushi District	✓	✓

* Current goitre prevalence rates are low (3.5%) but historical rates are high (20%)

Figure 1.1 Map showing the location of the three study areas in Xinjiang Province, China



Study Area 1 = Agricultural Commune 148, Shihezi County - Low IDD prevalence no iodine dripping
Study Area 2 = Kuqa District, Aksu County - High IDD prevalence, no iodine dripping
Study Area 3 = Wushi District, Aksu County - High IDD prevalence, iodine dripping

Plate 1.1 Typical irrigation channel in Wushi District (Study Area 3) harnessing melt water from the Tien Shan Mountains

Plate 1.2 The Taklimakan Desert basin rising to the Tien Shan foothills in the vicinity of Kuqa (Study Area 2)

Plate 1.3 Rock salt from a mine north of Kuqa (Study Area 2).

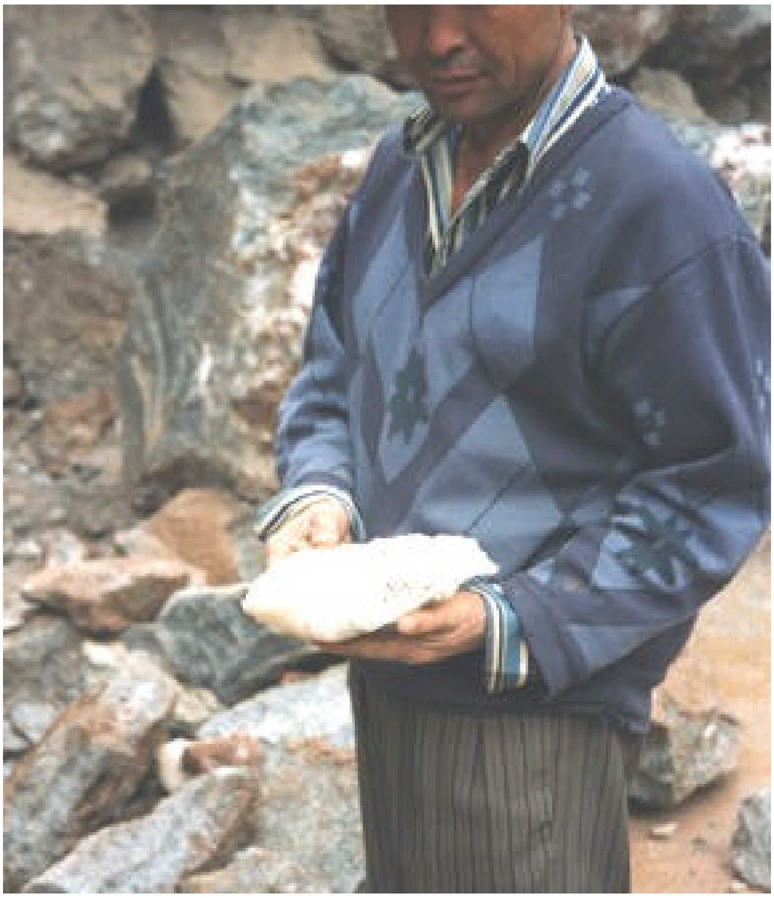


Plate 1.4 Site of iodine dripping on the main irrigation channel from the River Tuogishan in Wushi District (Study Area 3)

2 Sampling Design and Study Areas

2.1 SAMPLING DESIGN

The sample collection strategy applied in China is similar to that employed during previous projects to investigate links between trace elements in the environment and health (Fordyce et al., 2000; Johnson et al., 2002). Within each of the three study areas, five villages were selected for investigation and were coded according to the following scheme:

- Area 1, 1 – 5 Low/ no IDD 3.5% current goitre prevalence rate, no iodine dripping
- Area 2, 1 – 5 High IDD 30% goitre prevalence rate, no iodine dripping
- Area 3, 1 – 5 High IDD 40 – 50% goitre prevalence rate, iodine dripping

Based on the expertise of the Chinese project partners, villages that were representative of the three areas were chosen for the study. Soil, grain, vegetable, drinking water, human (school children) urine and blood-spot samples and thyroid-size measurements were collected from each village. This sampling strategy was designed to establish the relationship between the human iodine status of communities (represented by thyroid, blood-spot and urine samples); their dietary iodine intake (represented by staple grain, vegetable and drinking water samples) and the local geochemical environment characterised by cultivated soils.

The locations of the 15 study villages are shown on Figures 2.1 – 2.3 and summary information about each village is listed in Appendix A.

2.2 PHYSIOGRAPHY, GEOLOGY AND SOILS OF THE XINJIANG PROVINCE STUDY AREAS

As indicated in Chapter 1 of this report, the study areas selected for the current investigation are located on the arid margin of the Taklimakan Desert. Agricultural Commune 148 (Area 1) is situated approximately 165 km NNW of Urumqi, the capital of Xinjiang Province and lies to the north of the Tien Shan Mountain Range on the southern edge of the Gurbantunggutt Desert basin. Kuqa District (Area 2) lies on the main highway between Urumqi and Kashi on the northwest border of China at the base of the Tien Shan foothills on the northern edge of the Taklimakan desert basin approximately 200 km east of the County capital Aksu. Wushi District (Area 3) lies in the valley of the River Tuogishan (Plate 2.1) on the very northern margin of the Taklimakan desert basin in the foothills of the Tien Shan Mountains approximately 90 km west of Aksu (Figures 2.1 – 2.3). All three study areas are underlain by Quaternary, Pleistocene and Holocene aeolian and fluvial sedimentary deposits resulting in coarse sandy soils classified as brown desert soils in the Wushi and Kuqa regions and grey desert soils in Agricultural Commune 148 (Tan, 1989) (Li and Wu, 1999). Fluvio-aquatic soils predominate in the valley of the River Tuogishan in the Wushi area. The three areas lie within the gravelly and shrubby desert vegetation zone, with three crops per two-year rotation in irrigated areas (Tan, 1989).

2.3 AGRICULTURE, DIETARY AND MEDICAL INFORMATION

2.3.1 Area 1: Agricultural Commune 148

Agricultural Commune 148 (AC148) is the administrative centre for a highly organised system of farming villages developed on an irrigated plain. The area is one of the main cotton producing regions in China and the current cotton harvest is estimated at 46 million tonnes. The staple food crop grown in the region is wheat that is used to make noodles and bread. Cotton and wheat production are rotated but wheat is increasingly marginalized in favour of the more lucrative cotton crop. Nitrogen-phosphorous-potassium (NPK) fertiliser is used in the region but animal waste is not routinely applied to the fields. The cotton seedlings are protected under plastic sheeting for the first few months of cultivation and remnants of the sheeting are ubiquitous in the soils of the area. Food production in this area is often restricted to one part of the village and wheat and vegetables are commonly grown in one large field. The remainder of the irrigated land is turned over to cotton production (Plates 2.2 and 2.3). Cabbage, tomatoes, peppers, runner beans and carrots are the main vegetables consumed in the area. In winter, seafood and kelp also form part of the diet.

Wheat and cotton from the surrounding villages is stored and processed centrally in AC148 and children from the villages attend the AC148 Primary School. Therefore, in this area, grain and human samples were collected centrally in AC148 rather than in the individual villages.

Drinking water in this area is supplied from groundwater resources and is commonly pumped to a central water tower for each village.

The population in this area is of Chinese descent and has been subject to iodine-status assessments in the past. IDD surveys commenced in 1982. At that time, the goitre prevalence rate calculated on the whole population was 20%. In recent years the rate has been calculated on school children only so it is difficult to compare the old and new rates. In a study carried out in 1999 the rate was 3.5% (2 out of 56 school children studied) (Dr Wu pers. commun.).

Until four years ago, pregnant women and children were routinely given iodised oil capsules. Now all pregnant women are checked and given the capsules only if necessary. As part of the Chinese Government's on-going programmes, iodised salt has been available in the area for the past 15 years.

2.3.2 Area 2: Kuqa District in Aksu County

Kuqa Town is the administrative centre of the District which comprises agricultural villages scattered on an irrigated plain in the south and coal mining settlements in the more remote mountainous regions to the north. The population of Kuqa District is predominantly of Uiger descent, however, there is a large Chinese community particularly in Kuqa Town.

Cotton is grown in this region but not on the same scale as AC 148. The cotton seedlings are protected under plastic sheeting for the first few months of cultivation and remnants of the sheeting are ubiquitous in the soils of the area. Grapes are also an important crop. Wheat is the staple food crop and is used to make bread and noodles. Food production is carried out on land managed by farming families within each village and wheat is stored in individual homes. Therefore, in this area, soil, grain and vegetable samples were taken from representative fields and grain stores within each village. The main vegetables and fruit in the diet are cabbage, tomatoes, peppers, beans, rapeseed oil, grapes, watermelon apricots and walnuts. People of this region predominantly eat mutton and yoghurt is another common dietary constituent. Seafood and kelp are not consumed in this region. NPK fertilisers are used in this area and animal waste is applied to the land also.

Water supplies in this area are derived from shallow springs and groundwater aquifers pumped to homes in each village.

Children in the area attend local village primary schools. The Chinese project partners selected an appropriate school within each village at random for the present study.

Five years ago, the Kuqa Public Health Department carried out a survey of 5 villages in the area and the goitre prevalence rate was > 30%. Measurements were carried out by hand palpation and the goitres were all 1st and 2nd degree (WHO classification). A summary of past surveys in Qiman and Yaha villages is detailed in Table 2.1. The goitre rates for these two relatively developed villages range from approximately 3 – 17 %.

Although historically, cretinism was a problem in the District, the cretinism rate in the area is very low. Surveys of a population of 400 in a coal-mining village in the north of the District revealed 3 cases. There is no cretinism in the main populated area in the south of the District (Dr Abdula, pers. commun.).

The Government has made a commitment to eradicate IDD in China and several Public Health programmes have been implemented in this region. Iodised salt with minimum iodine content of 40 mg/kg (Chinese standard) is widely available throughout the District (Plate 2.4) and local health workers visit the villages every week with educational videos to promote the use of the salt. However, the local Uiger people prefer to eat rock salt and the take-up of iodised salt is very low (2% over the whole district). Rock salt is mined locally in sedimentary deposits in the mountains to the north of Kuqa Town. A typical mine, which has been in operation for 20 years produces 4000 tonnes of rock salt per year (Plate 2.5). The price of the iodised salt has recently increased and it is difficult to persuade people to change their habits especially as they have limited resources to buy the salt. The local Chinese population does use the iodised salt but goitre is still prevalent in this population group. A survey of goitre prevalence (measured by hand palpation) and iodised salt uptake was carried out in 7 villages, including Wuzun and Qiman, in the more developed southern area of the District in 1996, results are summarised in Table 2.2. Uptake of the salt at this time was approximately 40%.

In 1997 an iodised oil injection programme was carried out across the District involving 280 000 people in all villages. All 0 – 4 year-old children, pregnant women and recently married women received a 2 ml injection according to the doses detailed in Table 2.3. During this programme, goitre surveys were carried out in Wuzun, Yaha, Qiman, Waqiao and Sandaqiao villages as detailed in Table 2.4.

TABLE 2.3. IODISED OIL DOSES ADMINISTERED TO THE POPULATION OF KUQA DISTRICT IN 1997 (Dr Abdula, pers. commun.).

Age (Years)	Dose Oil (ml)
> 7	1
3 – 7	0.5
< 3	0.2

As part of the on-going Government IDD prevention scheme, in March 2000, iodised oil capsules (200 mg containing 40% iodine) were administered to 40 000 school children in the District.

Figure 2.1 Map of Agricultural Commune 148 (Study Area 1) showing the location of villages included in the present study.

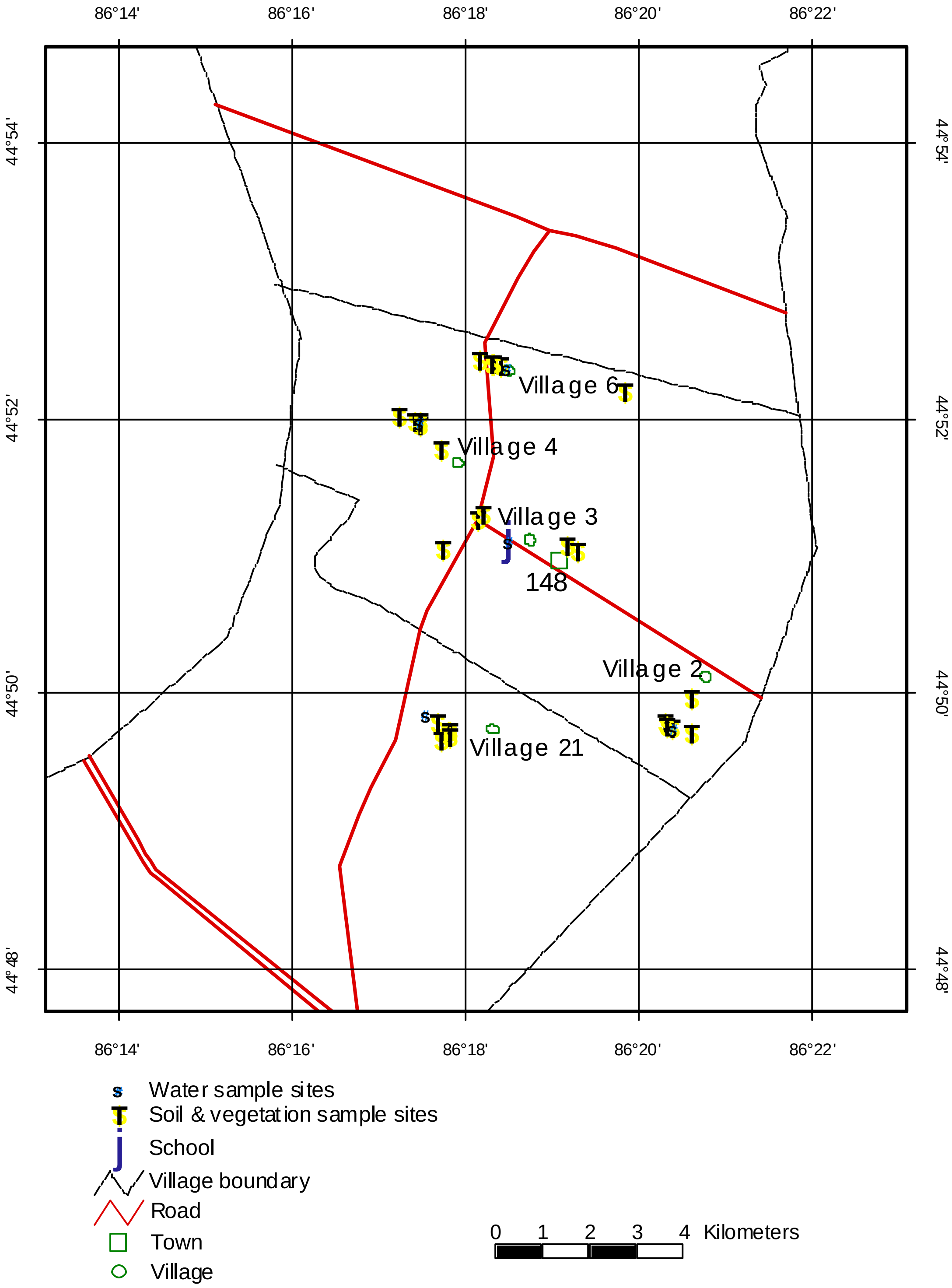


Figure 2.2 Map of Kuqa District (Study Area 2) showing the location of villages included in the present study.

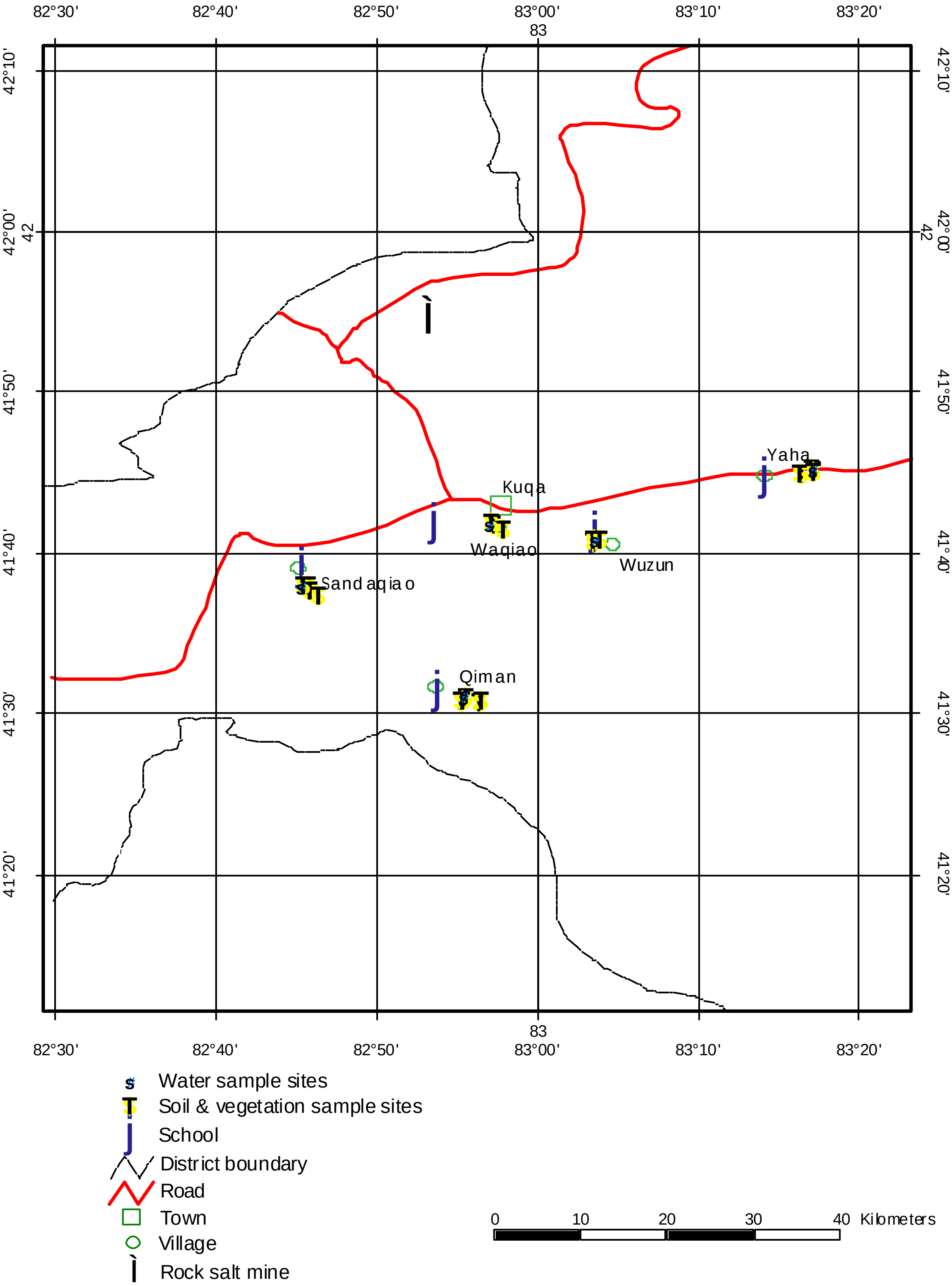


Figure 2.3 Map of Wushi District (Study Area 3) showing the location of villages included in the present study

(River Tuogishan flows from west to east)

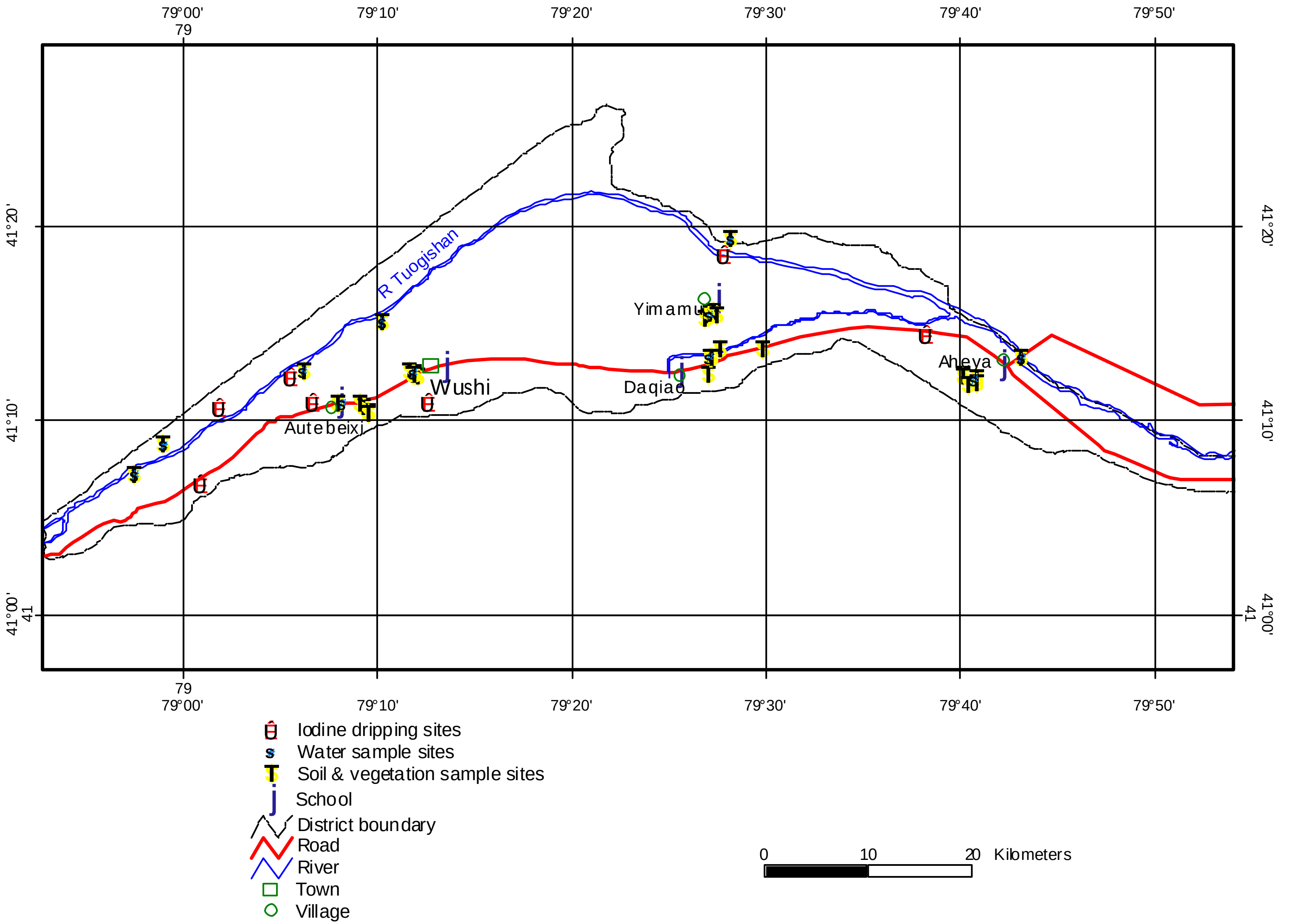


Plate 2.1 River Tuogishan at Wushi (Study Area 3)

Plate 2.2 Typical cotton field in Agricultural Commune 148 (Study Area 1).

Plate 2.3 Typical cabbage field (also used for growing wheat in rotation) in Agricultural Commune 148 (Study Area 1)

Plate 2.4 Iodised salt available in local markets, containing > 40 mg/kg iodine.

Plate 2.5 Rock salt mine to the north of Kuqa (Study Area 2).

TABLE 2.1. SUMMARY OF GOITRE PREVALENCE SURVEYS CONDUCTED IN YAHA AND QIMAN VILLAGES, KUQA DISTRICT BETWEEN 1987 AND 1994 (DR ABDULA, PERS COMMUN.)

Village	Rates	Year							
		1987	1988	1989	1990	1991	1992	1993	1994
Yaha	Sample Size	1223	1424	1425	1203	1332	1252	618	510
	All Children No of Goitres	28	65	77	147	87	121	55	28
	All Children Goitre Rate	2.28	4.56	5.40	12.20	6.53	9.60	9.00	5.50
	7 - 14 years Goitre Rate	*5.49*	*8.49*	*7.50*	*19.50*	*18.03*	*9.30*	*14.60*	*7.90*
Qiman	Sample Size	1478	1180	1350	1291	1279	1424	558	544
	All Children No of Goitres	97	83	107	167	151	129	97	51
	All Children Goitre Rate	6.51	7.03	7.92	12.93	11.80	9.76	17.40	9.37
	7 - 14 years Goitre Rate	*9.20*	*12.10*	*9.87*	*13.40*	*19.60*	*12.40*	*17.40*	*9.40*

TABLE 2.2. SUMMARY OF GOITRE PREVALENCE AND IODISED SALT SURVEYS CONDUCTED IN 7 VILLAGES INCLUDING WUZUN AND QIMAN, KUQA DISTRICT IN 1996 (Dr Abdula, pers commun.).

Village	Sample Size	No of Goitres	Goitre Rate %	Mean Urinary Iodine (mg/l)	No Taking I-salt	I-Salt Coverage Rate %	No of Salt Samples	No Containing 40 mg/kg
Wuzun	40	16	40.00	85.80	5	12.50	4	3
Qiman	40	17	42.50	166.43	21	52.50	17	14
7 Villages*	280	101	36.07	113.17	109	38.93	94	72

* includes Wuzun and Qiman

TABLE 2.4. SUMMARY OF GOITRE PREVALENCE AND IODISED OIL INJECTION PROGRAMMES CARRIED OUT IN KUQA DISTRICT IN 1997 (Dr Abdula, pers. commun.)

Village	Population	No of Goitres	Goitre Rate %	Children Aged 0 - 6		Children Aged 7 - 14	
				Total No	No Receiving Oil	Total No	No Receiving Oil
Wuzun	1628	95	5.8	3215	882	5825	5743
Yaha	9575	nd		3804	633	5553	4277
Qiman	11193	49	0.4	4360	4051	6289	6187
Sandaqiao	8131	143	1.8	3490	3441	4071	4005

2.3.3 Area 3: Wushi District, in Aksu County

Wushi Town is the administrative centre for a network of villages developed on an irrigated alluvial plain in the valley of the River Tuogishan.

The population of Wushi District is almost entirely of Uiger decent. Cotton is grown in this region but not on the same scale as AC 148. The cotton seedlings are protected under plastic sheeting for the first few months of cultivation and remnants of the sheeting are ubiquitous in the soils of the area. Grapes are also a very important crop, the average annual household income is approximately 1000 RMB (£83) from the sale of grapes and other fruit (Dr Jousip pers. commun.). Wheat is the staple food and is used to make bread and noodles. Maize is also grown in the region and the population occasionally buy rice from the market in Wushi Town. Food production is carried out on land managed by farming families within each village and wheat is stored in individual homes. Therefore, in this area, soil, grain and vegetable samples were taken from representative fields and grain stores within each village. Unlike the other two study areas, several farmers reported that their wheat production was not enough to supply their family needs therefore wheat is also bought-in from the market in Wushi Town. The main vegetables and fruit in the diet are cabbage, tomatoes, peppers, beans, rapeseed oil, grapes, watermelon apricots and walnuts. People of this region predominately eat mutton and yoghurt is another common dietary constituent. Seafood and kelp are not consumed in this region. No dietary surveys have been carried out in this area but estimates of likely dietary intake are shown in Table 2.5. NPK fertilisers are used in this area (10 – 20 kg per mu, 1 mu = 0.067 ha) and animal waste is applied to the land also.

TABLE 2.5. ESTIMATES OF DIETARY INTAKE IN WUSHI DISTRICT

Food	Dietary Intake Per Person Per Day	
	a	b
Wheat	0.5 kg	0.8 kg
Cabbage	0.3 – 0.5 kg	
Vegetables		0.5 kg
Fruit		0.5 kg
Water		2 l

a = Local farmers estimate   b = Dr Zhang estimate

Water supplies in this area are derived from the irrigation channels, from shallow groundwater wells and deeper aquifer resources. In each village, the water supply used by the majority of the population was sampled.

Children in the area attend local village primary schools. The Chinese project partners selected an appropriate school within each village at random for the present study.

Pre 1980 there were no systematic IDD surveys carried out this region but the area was famous for people with goitre known as 'pumpkin necks'. In a survey carried out over the whole of Aksu County in 1995 of 1200 8 – 10 year-old children, the goitre prevalence rate in the area was estimated at 45.6%. In a survey of west Aksu County including Wushi District in 1999 of 480 8 – 10 year-old children, the goitre prevalence rate was 60% (Dr Zhang, pers. commun.) Surveys were based on palpable hand determinations and the majority of goitres were grade 1 and 2 (WHO classification).

The people in this District cannot afford iodised salt and don't like the taste of it. The local population use rock salt, which is mixed with water to form a brine solution held in kitchen storage jars. The brine is used in cooking. Initiatives to encourage people to use iodised salt in the past have included posting guards at the rock salt mines to prevent extraction and providing subsidies for the purchase of iodised salt. The Public Health Bureau developed iodine releasers for use in the kitchen brine storage jars. Each releaser was designed to provide 200 μg/day per person for 3 – 5 people in each family. The releasers lasted for 1 year. This approach was adopted in Wushi and Kuqa Districts in 1995 for one year only as the Government emphasis shifted to encouraging uptake of iodised salt. An iodised oil programme similar to the one implemented in Kuqa was carried out during 1999/2000 in Wushi District also.

During 1999 as part of the XIDP, potassium iodate (KIO_3) was added to irrigation waters in the area according to the scheme summarised in Table 2.6. A 5% solution was dripped at a controlled rate from old metal oil barrels converted to dripping tanks placed on wooden frames over the irrigation channels (Shaohua and DeLong, 2000). Dripping was carried out over a 2 – 4 week period during May-June corresponding to the maximal irrigation of the fields devoted to wheat production during the mid-late growth phases of the crop. The locations of the dripping tanks are shown on Figure 2.3. Prior to dripping, the iodine content in urine and soils was determined in each village (Tables 2.7 and 2.8). Results of a soil survey after the dripping process revealed a very significant increase in soil water-soluble iodine contents (Table 2.8).

Table 2.6. Proposals for the 1999 iodine dripping programme in Wushi District (SHAOHUA AND DELONG, 2000)

Village	Population	Potassium Iodate (kg)	Number of Tanks	Land Area (mu)*
Daqiao	14160	90	9	66256
Wushi Town	4038	20	2	7293
Aheya	28207	170	17	84805
Autebeixi	19037	120	12	59433
Yimamu	17528	140	14	87422

* 1 mu = 0.067 ha

TABLE 2.7. URINE IODINE CONTENTS IN WUSHI DISTRICT IN 1998 PRIOR TO IODINE DRIPPING (SHAOHUA AND DELONG, 2000)

Village	Number of Samples	Urinary Iodine (µg/l) Median	Geomean	Standard Dev.
Daqiao	5	104.81	99.71	254.15
Wushi Town	5	192.52	168.18	63.51
Aheya	5	127.44	131.50	70.97
Autebeixi	4	109.09	120.12	63.55
Yimamu	4	61.07	99.71	254.15

Dev = Deviation

TABLE 2.8. SOIL WATER SOLUBLE IODINE CONTENTS IN WUSHI DISTRICT IN 1999 PRIOR TO AND POST IODINE DRIPPING (SHAOHUA AND DELONG, 2000)

Village	Pre-dripping			Post-dripping		
	Number of Samples	Soil water soluble Iodine (ng/g) Average	Standard Dev.	Number of Samples	Soil water soluble Iodine (ng/g) Average	Standard Dev.
Daqiao	5	17.60	5.55	5	124.44	67.94
Wushi Town	5	17.90	5.86	5	108.70	54.85
Aheya	5	23.20	4.69	5	104.60	36.13
Autebeixi	5	17.10	7.05	5	112.60	112.60
Yimamu	5	12.70	6.03	5	98.60	98.60

Dev = Deviation

3 Geochemical Surveys

3.1 SAMPLING METHODS

3.1.1 Sampling Design

In order to determine the geochemical environment of the three study areas, in each of the 15 villages a suite of geochemical samples was collected following sampling strategies developed during previous geochemistry and health studies (Johnson et al., 2000) (Fordyce et al., 2000). In each village 5 topsoil samples, 5 wheat (staple grain), 3 cabbage (stable vegetable) and 1 drinking water sample were collected. In order to examine the dispersion of iodine in the environment in Wushi District (Area 3) where iodine-dripping technology has been applied to the irrigation system, 7 additional water and soil samples were collected from the River Tuogishan, which drains the iodinated, irrigated zone (Plate 2.1).

Samples were coded UR for Urumqi and numbered according to a random number list. Sample details were recorded on field cards. Village and sample details are summarised in Appendices A-D. Field sampling equipment is listed in Appendix E.

In addition to the total iodine concentration of environmental materials, many other factors can influence the mobility of iodine in the environment and uptake into crops and the human food chain. Factors that control the mobility of iodine in soils such as pH, organic matter content and major element chemistry included in the present study to enhance the understanding of the environmental controls on iodine uptake in the three study areas.

3.1.2 Soil Sampling and Preparation

Soil samples were collected from cultivated land in and around the targeted villages (Plate 3.1). The soils were generally very dry when collected, however, in some recently irrigated fields the soils were damp but not waterlogged.

(a) All sampling equipment (stainless steel trowel and plastic sheet) was cleaned before use.

(b) Using the trowel, four holes were made at the corners of a 20 m square and the fifth hole in the centre of the square. The top c.1 cm organic rich layer was discarded and the samples collected from approximately 2 – 15 cm depth. The five sub-samples were placed on a plastic sheet.

(c) Any large rootlets and stones were hand picked from the sample and discarded.

(d) The accumulated sample was homogenised on the plastic sheet.

(e) The sample was placed in a grey securitainer (49 x 75 mm) and black waterproof marker pen was used to write the number carefully on the top, side and bottom of the securitainers (to avoid the number being rubbed off during transport). Sample containers were also coded with the letter S to indicate they contained a soil sample. The grey securitainer samples were transported back to the UK for sample preparation in by BGS.

(f) Sample field cards were completed at each site noting site characteristics (see Annex B).

(g) Duplicate soil samples were collected in the same way, from five different holes in the same field as the original sample.

(h) On return to the BGS laboratory samples were again homogenised and coned and quartered. One quarter of the sample was returned to the original contained and stored for future reference.

(i) Duplicate samples were split to give analytical sub-samples to be used for monitoring analytical precision and accuracy.

(j) The soils were dried in an oven at less than 30º C then dissaggregated.

(k) A 10 g split of the sample was set aside for soil pH determination and 5 g for soil colour determination.

(l) The remaining sample was sieved to - 2 mm. From this fraction 2 g was taken for loss-on-ignition determination (LOI).

(m) The -2mm fraction was pulverised in an agate ball mill to -150µm.

(n) 10 g of each pulverised sample was placed in a small securitainer pot and sent to the IRMA laboratories for trace and major element analyses.

(o) 10 g of each pulverised sampled was submitted to the BGS analytical laboratories for iodine determinations, imported to the UK under the terms of the MAFF import licence.

(p) Excess pulverised material is stored for future reference. Following receipt of the LOI results thirty samples were selected for Se, total organic carbon (TOC) and cation exchange capacity (CEC) analysis.

Plate 3.1. Soil sample collection in Wushi (Study Area 3)

3.1.3 Water Sampling

In Agricultural Commune 148, the villages were supplied by water pumped from underground aquifers and stored in water tanks in each village. In the Kuqa and Wushi areas the population used water from shallow and deeper aquifers and surface water sources for drinking. In each village, the water supply applicable to the majority of the population was sampled. Therefore a variety of deep groundwater from taps, shallow groundwater from pumps and surface water from irrigation channels was collected during the present study (Plates 3.2 and 3.3). Where possible taps and pumps were flushed through for several minutes before the sample was collected. In some villages, piped water was only available at certain times of day and water was therefore collected from water storage containers.

(a) At each site, the following suite of water samples were collected:

- One 30 ml filtered water sample collected in trace element free polyethylene Nalgene® bottles for iodine analysis labelled I.
- One 30 ml filtered acidified water sample collected in a polystyrene Steralin® vial for major cation analysis labelled F/A.
- One 30 ml filtered unacidified water sample collected in a polystyrene Steralin® vial for major anion analysis labelled F/UA.
- One 30 ml unfiltered water sample collected in a polystyrene Steralin® vial for pH and Eh determinations.
- One 250 ml unfiltered water sample collected in a polyethylene bottle for bicarbonate and conductivity determinations.

(b) A waterproof black marker pen was used to write the sample number clearly on the tops and sides of the bottles.

(c) Each filtered water sample was collected using a 25 ml plastic syringe and a disposable Millipore® 0.45µm filter. A new filter cartridge was used for each site to avoid any possible cross-contamination between sites.

(d) At each site the filtered water samples were collected first avoiding disturbance to water in the container used in each household.

Plate 3.2. Collection of water sample from a tap in a home in Wushi District (Area 3)

(e) Water was drawn into the syringe, which was rinsed out twice. The syringe was filled with water again and connected to the filter cartridge, which was also rinsed out twice. The syringe was refilled and the sample bottle was rinsed out twice with filtered water prior to being filled. The 30 ml Nalgene® bottles were filled to the shoulder.

(f) For unfiltered water samples, both the 30 ml Steralin® vial and the 250 ml polyethylene bottle for pH, Eh and conductivity determinations were rinsed out twice in the water. Where possible, the vial and the bottle were both submerged underwater whilst the caps were secured making sure that no air was trapped in the sample container. This minimises the degassing of HCO_3 in the samples.

(g) Care was taken to keep all bottles and filters clean.

Plate 3.3 Collection of 0.45 µm filtered water sample for iodine analysis.

(h) Duplicate samples were collected in the same way from the same water source as the original samples.

(i) 30 ml samples collected for major cation analysis were acidified within 4 hours of the end of fieldwork each day by the addition of 0.3 ml (8 drops) ARISTAR grade nitric acid. Addition of 1% vol/vol acid reduces the pH of the samples to approximately 1.0, thus preventing adsorption of dissolved metals to the interior walls of the storage bottle and minimising post-sampling microbial activity.

(j) One NaOH pellet was added to each of the samples collected for iodine analysis to maintain alkaline pH ensuring any iodine present remained in solution

(k) Care was taken to avoid introducing contamination through the plastic dropping pipettes, each of which were stored in a plastic self-seal bag and did not come into contact with bench surfaces.

(l) Eh and pH measurements, bicarbonate and conductivity determinations were also carried out at the end of each day's sampling. Procedures are detailed in Section 3.2. Following the measurements, these samples were discarded and the sampling containers reused.

(m) Three field-blank iodine, filtered acidified, and filtered unacidified samples were made up near the start and end of fieldwork. Bottles were rinsed twice with filtered deionised water, filled to the shoulder with filtered deionised water and acidified/ treated in the same way as the samples. The field-blanks were numbered in the same way as the samples according to the random list.

(n) At all stages great care was taken to ensure that sample bottle tops were securely tightened.

(o) The 30 ml Steralin® vials were transported back to the UK for analysis at BGS laboratories for Ca, Mg, K, Na, Cl, NO_3, SO_4 and F.

(p) The 30 ml Nalgene® bottles were transported back to Urumqi for iodine analysis at the EDI laboratories.

3.1.4 Vegetable and grain sampling and preparation

Wheat and cabbage were the two staple crops grown in all three-study areas. Within each village, 5 wheat and 3 cabbage samples were collected. In Agricultural Commune 148, wheat from the surrounding villages was held in a central storage facility in AC148 town. In this study area, it was not possible to collect wheat samples from individual villages but 15 samples were collected from different wheat storage areas within the central facility to give samples representative of the area (Plate 3.4)

In Kuqa and Wushi Districts, wheat was stored on individual farms. Within each village, wheat samples were collected from 5 household stores corresponding to fields from which soil samples had been collected (Plate 3.5).

Samples were collected in cloth bags labelled with the sample number and G for grain.

Unlike the wheat crop, the cabbage crop was growing in the fields at the time of sampling. Five sub-samples of leaves were collected from cabbages at each corner and in the middle of a 20 m square within each field sampled. Leaves were collected into a cloth bag labelled with the sample number and V for vegetable (Plate 3.6).

Duplicate samples were collected in the same way, from the same grain store and from cabbage plants in the same field as the original samples.

Samples were submitted to the analytical laboratories of the EDI in Urumqi for preparation and determination of iodine.

(a) Samples were washed with deionised water

(b) Samples were air dried

(c) A coffee blender was used to powder each vegetable and grain sample.

Plate 3.4 Collection of wheat sample from the main grain store in Agricultural Commune 148 (Area 1).

Plate 3.5. Collection of wheat sample from a household grain store in Wushi (Area 3).

3.1.5 Rock Salt and Coal Samples

Two samples of rock salt, one grey in colour the other white were collected from a rock salt mine to the north of Kuqa and a sample of coal used for fuel in local homes was also collected in Kuqa town to assess the iodine contents. These samples were prepared in the same way as the soil samples.

Plate 3.6 Collection of a cabbage sample, leaves from 5 cabbages within the same field were collected and combined to form one sample.

3.2 ANANLYTICAL METHODS

The analytical methods described below were carried out in the BGS laboratories unless specified otherwise.

3.2.1 Field Methods

Water pH, temperature, Eh, total alkalinity and conductivity were determined on the water samples during the evening after their collection. These methods are detailed in Appendix F.

3.2.2 Soil Analyses

3.2.2.1 COLOUR

Soil colour was determined using Munsell® Soil Colour Charts on the dry pulverised powders. A Munsell colour code was determined for each sample and soils were grouped into general colour ranges based on the Munsell soil colour name diagram.

3.2.2.2 PH

Soil pH was determined on 10g of the unprepared soil sample to which 10ml of 0.01M $CaCl_2$ solution had been added. The pH of the soil paste was measured with a standard Orion® pH meter. This method of soil pH determination generally gives lower results (0.5 pH units) than water based methods (Appendix B).

3.2.2.3 LOSS-ON-IGNITION (LOI)

Accurately weighed sample powders dried at 35°C ± 5°C were placed in a furnace at 105°C and heated to 450°C for a minimum of 4 hours. The percentage weight loss after ignition at 450°C can be used as an indication of the amount of organic matter present.

3.2.2.4 TOTAL ORGANIC CARBON (TOC)

Total organic carbon contents were determined on 30 selected soils (two from each village). The analysis was performed using a LECO CS125 Carbon Analyser (at Geolab, UK). Ground samples are accurately weighed into LECO crucibles. They are treated 4 times with hot 10% HCl to remove oxidised carbon (carbonate) followed by 4 washes with distilled water. The samples are then dried in an oven at 60 °C prior to analysis. The instrument is calibrated with a LECO carbon steel ring.

3.2.2.5 CATION EXCHANGE CAPACITY (CEC)

Cation exchange capacity was determined in 30 selected soils (two from each village). The technique used is based on the compulsive exchange between aqueous solution of $MgSO_4$ and a barium soil (Bascomb, 1964). Samples were saturated with Ba, supplied as $BaCl_2$ solution, and any excess was removed by washing with deionised water. $MgSO_4$ solution was added to the soil and left for 2 hours. Barium is removed as insoluble $BaSO_4$, and the amount of Mg exchanged was determined by titrating the excess $MgSO_4$ solution with EDTA.

3.2.2.6 TOTAL IODINE AND WATER SOLUBLE IODINE

The total and water-soluble iodine content of soils were determined by vapour generation inductively coupled atomic emission spectrometry (ICP-AES) according to the methods outlined in Appendix G.

3.2.2.7 MAJOR AND TRACE ELEMENTS (DETERMINED BY IRMA)

Major cations (Al, Fe, Ca, Mg, Mn) and trace elements (Cu, Ni, Zn) were determined in the soils by ICP-AES following a hot acid (HNO_3-$HClO_4$) digestion (Fordyce et al., 1998). Total Se was determined in 30 selected soils (two from each village) by Atomic Fluorescence Spectrometry (AFS) (Fordyce et al., 1998).

3.2.3 Water Analyses

3.2.3.1 IODINE (DETERMINED BY EDI)

Iodine was determined by Barker's modified incineration technique and catalytic reduction of the ceric ion (Ce^{4+}) by arsenite salt (As^{3+}) (See section 3.2.4.1 below)

3.2.3.2 CA, MG, K, NA, F, NO_3, SO_4, CL

Major cation (Ca, Mg, K, Na) determinations were carried out by ICP-AES and anion determinations by ion chromatography (IC) at the BGS laboratories in Keyworth (Appendix G).

3.2.4 Vegetable Analyses

3.2.4.1 IODINE (EDI)

Total iodine concentrations in grain and cabbage leaf samples were determined by Barker's modified incineration technique. 0.5 g of ground powder were weighed into a test tube. Dilute NaOH was added followed by $ZnSO_4$. The sample was digested and dilute HCl and H_2SO_4 added to neutralise the alkaline solution. As^{3+} and Ce^{4+} were added and the analytes were heated in a water bath at 39°C for 10 minutes before the solution colour was determined. Results are reported as dry weight (DW).

3.3 DATA QUALITY CONTROL

In any scientific study it is important to document the reliability of the sampling and analytical methods to prove that the study is robust. During the present study, data quality was assured by the collection of field duplicate samples and the inclusion of blank water samples, analytical replicates and international reference materials in the analytical runs. Results of these determinations are detailed in the following sections.

3.3.1 Limits of Detection (LOD)

The LOD for the various types of analysis are listed in Table 3.1.

TABLE 3.1 LIMITS OF DETECTION FOR EACH ANALYTICAL METHOD

Method	Sample Type	Determinant	LOD
ICP-AES	Soil	Total I	0.5 µg/g
ICP-AES	Soil	Water Sol. I	0.020 µg/g
Barker's ^	Wheat	I	1 µg/100g DW
Barker's ^	Cabbage	I	1 µg/100g DW
Barker's ^	Water	I	0.07 µg/l
ICP-AES *	Soil	Al	0.05 wt%
ICP-AES *	Soil	Fe	0.05 wt%
ICP-AES *	Soil	Ca	0.05 wt%
ICP-AES *	Soil	Mg	0.05 wt%
ICP-AES *	Soil	Mn	10 µg/g
ICP-AES *	Soil	Cu	2 µg/g
ICP-AES *	Soil	Ni	4 µg/g
ICP-AES *	Soil	Cu	2 µg/g
ICP-AES *	Soil	Zn	1 µg/g
AFS *	Soil	Se	0.01 µg/g
ICP-AES	Water	Ca	0.10 mg/l
ICP-AES	Water	Mg	0.01 mg/l
ICP-AES	Water	Na	0.35 mg/l
ICP-AES	Water	K	0.50 mg/l
IC	Water	Cl	0.10 mg/l
IC	Water	SO_4	0.30 mg/l
IC	Water	NO_3	0.30 mg/l
IC	Water	Br	0.03 mg/l
IC	Water	NO_2	0.01 mg/l
IC	Water	F	0.05 mg/l

^ EDI laboratories Urumqi * IRMA laboratories Beijing
Unless otherwise stated, BGS laboratories Keyworth Sol = Soluble

3.3.2 Analytical Replicate Results

Repeat analyses were carried out on soil, cabbage, wheat and water samples. Analytical replicate results for soil pH (BGS laboratories), soil elements apart from iodine (IRMA laboratories), and iodine in water and wheat samples (EDI laboratories) show good repeatability of the methods (Table 3.2). However, results for iodine in cabbage samples (EDI laboratories) show marked variation (> 20%) for sample UR11. Total and water soluble iodine in soil replicates show marked variation (> 20%) at low concentrations close to the detection limits (Table 3.2 and Appendix G).

3.3.3 Sample Replicate Results

Six soil, wheat and cabbage replicates prepared by cone and quartering a sub-sample from the original material were analysed to assess the homogeneity of the samples and the reliability of the analytical methods. Soil major and trace element analyses (IRMA laboratories), soil LOI and pH determinations (BGS laboratories) and iodine contents in wheat and cabbage (EDI laboratories) show generally good repeatability of the results (< 20% variation) (Table 3.3). However, soil total and water-soluble iodine contents (BGS laboratories) show marked variability (> 20%) at low concentrations close to the detection limit (Table 3.3).

3.3.4 Field Duplicate Results

Results for field duplicates indicate that in general, variability between samples collected in the same location is low (< 20%) (Table 3.4). Duplicate pair UR28/UR7 show marked variability (> 20%) for CEC in soils probably due to differences in soil type within the same field. Soil total iodine concentrations show marked variability (> 20%) in this and UR71/UR66 duplicate pairs due to proximity of concentrations to the limits of detection and possible differences in soil types collected in the same field. Samples UR28/UR7 and UR71/UR66 show very marked variability (> 20%) for iodine concentrations in wheat indicating differences in samples from the same grain store. Water duplicate pair UR7/UR28 has very differing nitrite and nitrate concentrations. In the case of nitrite this may be due to proximity of the concentrations to the LOD but may also represent differing chemistry or reactions following collection between the duplicate samples.

3.3.5 Results for International Standards

The accuracy of the analytical methods was determined by the inclusion of international standards in the analytical runs (Table 3.5). In general, the results demonstrate good precision of the methods, however total iodine concentrations in soil standards GBW07401 and GBW07401 and iodine concentrations in the tomato leaf standard SRM1573a are lower than the reference values probably due to differences in the analytical methods adopted. In particular the tomato leaf reference value is not certified and was determined by ICP-AES rather than the modified Barker's technique used in the present study.

3.3.6 Data Processing

Results for analytical replicates, sample replicates and field duplicates were averaged and results below the LOD set to 2/3 of the detection limit for the purposes of data interpretation and statistical analyses. Results for soil and water analysis collected along the River Tuogishan in the Wushi study area were considered separately from the interpretation and statistical analysis of village soil and water results. Spearman Rank non-parametric correlation coefficients were calculated for statistical analysis, as these are less sensitive to outlying values than product moment (Pearson) correlations.

TABLE 3.2 ANALYTICAL REPLICATE RESULTS FOR SOIL, CABBAGE AND WATER SAMPLES

Sample No	Soil pH
UR6	8.20
UR6	8.20
V	*0.00*
UR10	7.70
UR10	7.70
V	*0.00*
UR17	8.00
UR17	8.00
V	*0.00*
UR19 SS A2	7.70
UR19 SS A2	7.80
V	*0.91*
UR25	8.40
UR25	8.40
V	*0.00*
UR33	7.70
UR33	7.80
V	*0.91*
UR35	9.40
UR35	9.40
V	*0.00*
UR46	7.90
UR46	7.90
V	*0.00*
IS GBW07402	8.60
IS GBW07402	8.70
V	*0.82*
UR54 Dup A2	7.70
UR54 Dup A2	7.80
V	*0.91*
UR56	8.70
UR56	8.60
V	*0.82*
UR66 Dup B1	7.80
UR66 Dup B1	7.90
V	*0.90*
UR92	8.20
UR92	8.20
V	*0.00*
UR98	7.70
UR98	7.80
V	*0.91*

Sample No	Soil WSol I µg/g
IS GBW07402	#0.012
IS GBW07402	#0.02
V	*35.36*
UR7	0.020
UR7	#0.012
V	*35.35*
UR15	0.030
UR15	#0.02
V	*28.28*
UR28	#0.012
UR28	#0.012
V	*0.00*
UR36	#0.012
UR36	#0.012
V	*0.00*
UR38	#0.012
UR38	#0.012
V	*0.00*
UR50	#0.012
UR50	#0.012
V	*0.00*
UR54	#0.02
UR54	#0.02
V	*0.00*

Sample No	Soil Total I µg/g	Soil Al wt%*	Soil Fe wt%*	Soil Ca wt%*	Soil Mg wt%*	Soil Mn µg/g*	Soil Cu µg/g*	Soil Ni µg/g*	Soil Zn µg/g*	Soil Se µg/g*
IS GBW07309		5.99	3.49	4.19	1.51	622.00	37.20	26.50	79.10	
IS GBW07309		5.96	3.65	4.52	1.50	644.00	39.60	26.90	82.90	
V		*0.36*	*3.17*	*5.36*	*0.47*	*2.46*	*4.42*	*1.06*	*3.32*	
IS GBW07401										0.14
IS GBW07401										0.17
										13.69
IS GBW07402	1.54									0.19
IS GBW07402	1.42									0.17
V	*5.70*									*7.86*
UR7	1.40									
UR7	0.99									
V	*23.83*									
UR16	#0.5									
UR16	#0.25									
V	*47.14*									
UR24	0.87									
UR24	0.96									
V	*6.84*									
UR31	1.27									
UR31	1.41									
V	*7.02*									
UR42	0.59									
UR42	0.69									
V	*11.59*									
UR58	0.83									
UR58	1.18									
V	*24.87*									
UR65	1.96									
UR65	1.22									
V	*32.92*									
UR75	0.91									
UR75	1.33									
V	*26.64*									
UR82	0.58									
UR82	0.66									
V	*9.10*									
UR93	1.05									
UR93	1.19									
V	*8.81*									

Sample No	Cabbage I µg/100g^ DW
UR11	11.24
UR11	7.74
V	*26.08*
UR92	8.42
UR92	9.13
V	*5.72*
UR98	14.19
UR98	15.32
V	*5.42*

Sample No	Water I µg/l
UR58	3.20
UR58	2.99
V	*4.80*
UR66 Dup B1	98.00
UR66 Dup B1	95.00
V	*2.20*
UR77	3.30
UR77	3.00
V	*6.73*

V = coefficient of variation expressed as % Unless otherwise stated, BGS lab analysis ^ EDI lab analysis * IRMA lab analysis Dup = Field Duplicate IS = International Standard # At or below LOD WSol = Water Soluble
DW = dry weight

TABLE 3.3 SAMPLE REPLICATE RESULTS FOR SOIL, CABBAGE AND WHEAT SAMPLES

LIMS ID	Sample No.	Soil													Wheat I µg/100g^ DW	Cabbage I µg/100g^ DW
		Al wt%*	Fe wt%*	Ca wt%*	Mg wt%*	Mn µg/g*	Cu µg/g*	Ni µg/g*	Zn µg/g*	Se µg/g*	Total I µg/g	WSol I µg/g	pH	LOI @ 450°C		
06873-00066	UR71 Dup A1	6.22	3.10	4.54	1.34	606.00	28.00	27.00	75.00	0.19	1.58	#0.012	7.90	2.82	8.95	12.46
06873-00057	UR60 SS A1	6.86	3.09	4.51	1.37	605.00	27.00	26.00	72.00	nd	1.60	#0.012	7.90	3.06	7.12	11.74
V		*6.92*	*0.23*	*0.47*	*1.57*	*0.12*	*2.57*	*2.67*	*2.89*	*nd*	*0.76*	*0.000*	*0.00*	*5.77*	*16.105*	*4.21*
06873-00062	UR66 Dup B1	7.00	3.28	4.61	1.40	619.00	29.00	27.00	76.00	0.21	2.75	#0.012	7.85	3.04	5.40	10.72
06873-00031	UR34 SS B1	6.56	3.06	4.40	1.39	584.00	26.00	25.00	72.00	nd	1.88	#0.012	7.90	2.80	5.17	10.12
V		*4.59*	*4.91*	*3.30*	*0.51*	*4.11*	*7.71*	*5.44*	*3.82*	*nd*	*26.47*	*0.000*	*0.45*	*5.81*	*3.08*	*4.07*
06873-00051	UR54 Dup A2	5.43	2.85	10.20	1.96	622.00	29.00	23.00	83.00	nd	0.60	#0.02	7.75	3.42	10.54	8.08
06873-00016	UR19 SS A2	5.44	2.77	9.81	1.93	599.00	26.00	22.00	80.00	nd	0.71	#0.012	7.75	3.51	10.45	8.02
V		*0.13*	*2.01*	*2.76*	*1.09*	*2.66*	*7.71*	*3.14*	*2.60*	*nd*	*11.51*	*35.355*	*0.00*	*1.84*	*0.61*	*0.53*
06873-00028	UR30 Dup B2	5.54	2.84	10.11	1.97	606.00	29.00	24.00	85.00	nd	#0.44	#0.012	7.80	3.67	10.20	8.65
06873-00006	UR8 SS B2	5.47	2.77	9.76	1.94	596.00	30.00	22.00	80.00	nd	0.69	#0.012	7.90	3.40	9.91	7.92
V		*0.90*	*1.76*	*2.49*	*1.09*	*1.18*	*2.40*	*6.15*	*4.29*	*nd*	*31.45*	*0.000*	*0.90*	*5.40*	*2.04*	*6.23*
06873-00026	UR28 Dup A3	6.01	2.92	9.68	1.59	687.00	31.00	27.00	97.00	0.22	1.16	#0.012	7.80	2.96	3.41	13.74
06873-00050	UR53 SS A3	5.78	2.96	9.79	1.54	671.00	27.00	25.00	72.00	nd	#0.40	#0.02	7.70	2.85	3.14	14.16
V		*2.76*	*0.96*	*0.80*	*2.26*	*1.67*	*9.75*	*5.44*	*20.92*	*nd*	*68.82*	*35.355*	*0.91*	*2.68*	*5.83*	*2.13*
06873-00005	UR7 Dup B3	5.99	2.89	9.52	1.59	661.00	28.00	22.00	72.00	0.28	1.20	#0.016	8.10	2.85	12.88	10.35
06873-00048	UR51 SS B3	5.76	2.91	9.45	1.52	670.00	40.00	24.00	72.00	nd	0.91	#0.02	8.00	2.90	12.70	10.45
V		*2.77*	*0.49*	*0.52*	*3.18*	*0.96*	*24.96*	*6.15*	*0.00*	*nd*	*19.59*	*15.713*	*0.88*	*1.23*	*1.00*	*0.68*

V = coefficient of variation expressed as % Dup = Field Duplicate SS = Sub-sample replicate # At or below LOD nd = no data

* IRMA laboratory analysis ^ EDI laboratory analysis Unless otherwise stated, BGS laboratory analysis WSol = Water Soluble DW = dry weight

TABLE 3.4 FIELD DUPLICATE RESULTS FOR SOIL, CABBAGE, WHEAT AND WATER SAMPLES

LIMS ID	Sample No.	Soil																Wheat I μg/100g^	Cabbage I μg/100g^
		Al wt%*	Fe wt%*	Ca wt%*	Mg wt%*	Mn μg/g*	Cu μg/g*	Ni μg/g*	Zn μg/g*	Se μg/g*	Total I μg/g	WSol I μg/g	CEC meq/100g	% TOC	% Moisture @ 105°C	pH	LOI @ 450°C	DW	DW
06873-00066	UR71 Dup A1	6.54	3.10	4.53	1.36	605.50	27.50	26.50	73.50	0.19	1.59	#0.012	14.94	0.75	1.68	7.90	2.94	8.04	12.10
06873-00062	UR66 Dup B1	6.78	3.17	4.51	1.40	601.50	27.50	26.00	74.00	0.21	2.32	#0.012	13.71	0.78	1.63	7.88	2.92	5.29	10.42
V		*2.55*	*1.69*	*0.31*	*2.06*	*0.47*	*0.00*	*1.35*	*0.48*	*7.07*	*26.43*	*0.00*	*6.06*	*2.77*	*1.89*	*0.22*	*0.48*	*29.20*	*10.55*
06873-00051	UR54 Dup A2	5.44	2.81	10.01	1.95	610.50	27.50	22.50	81.50	nd	0.66	#0.016	nd	nd	nd	7.75	3.47	10.50	8.05
06873-00028	UR30 Dup B2	5.51	2.81	9.94	1.96	601.00	29.50	23.00	82.50	nd	0.57	#0.012	nd	nd	nd	7.85	3.54	10.06	8.29
V		*0.90*	*0.13*	*0.50*	*0.36*	*1.11*	*4.96*	*1.55*	*0.86*	*nd*	*10.61*	*20.20*	*nd*	*nd*	*nd*	*0.91*	*1.41*	*3.03*	*2.03*
06873-00026	UR28 Dup A3	5.90	2.94	9.74	1.57	679.00	29.00	26.00	84.50	0.22	0.78	#0.016	14.41	0.92	0.89	7.75	2.91	3.28	13.95
06873-00005	UR7 Dup B3	5.88	2.90	9.49	1.56	665.50	34.00	23.00	72.00	0.28	1.05	#0.018	9.72	0.96	0.91	8.05	2.88	12.79	10.40
V		*0.24*	*0.97*	*1.84*	*0.45*	*1.42*	*11.22*	*8.66*	*11.30*	*16.97*	*20.98*	*8.32*	*27.45*	*3.01*	*1.80*	*2.69*	*0.73*	*83.76*	*20.62*

LIMS ID	Sample No.	Water															
		I μg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	Br mg/l	NO_2 mg/l	F mg/l	pH	Temp °C	Conductivity μS	Alkalinity mg/l $CaCO_3$	Corrected Eh mV
06873-00066	UR71 Dup A1	88.00	2.19	0.40	105.21	0.50	33.00	50.50	0.30	#0.03	#0.01	0.99	9.25	24.60	534.00	127.00	333.20
06873-00062	UR66 Dup B1	96.50	2.21	0.46	111.78	0.50	32.60	50.60	0.30	#0.03	#0.01	0.91	9.23	24.40	538.00	125.00	335.70
V		*6.52*	*0.93*	*10.06*	*4.28*	*0.00*	*0.86*	*0.14*	*0.00*	*0.00*	*0.00*	*5.95*	*0.15*	*0.58*	*0.53*	*1.12*	*0.53*
06873-00051	UR54 Dup A2	0.90	78.64	33.05	28.28	4.44	31.70	70.70	11.30	#0.03	#0.01	0.17	7.47	22.80	758.00	225.00	300.30
06873-00028	UR30 Dup B2	1.00	80.01	33.97	30.40	4.09	32.50	71.90	11.70	#0.03	#0.01	0.17	7.49	21.60	722.00	224.00	308.40
V		*7.44*	*1.23*	*1.93*	*5.11*	*5.82*	*1.76*	*1.19*	*2.46*	*0.00*	*0.00*	*2.11*	*0.19*	*3.82*	*3.44*	*0.31*	*1.88*
06873-00026	UR28 Dup A3	4.40	174.86	61.04	121.02	8.91	164.00	291.00	16.50	0.06	#0.01	0.08	7.31	18.50	1820.00	282.00	277.40
06873-00005	UR7 Dup B3	3.70	172.15	59.62	118.03	8.75	177.00	309.00	8.54	0.05	0.19	0.11	7.29	18.10	1840.00	288.00	282.20
V		*12.22*	*1.10*	*1.67*	*1.77*	*1.30*	*5.39*	*4.24*	*44.96*	*17.18*	*127.28*	*22.33*	*0.19*	*1.55*	*0.77*	*1.49*	*1.21*

V = coefficient of variation expressed as % Dup = Field Duplicate # At or below LOD nd = no data WSol = Water Soluble

* IRMA laboratory analysis ^ EDI laboratory analysis Unless otherwise stated, BGS laboratory analysis DW = dry weight

TABLE 3.5 RESULTS (DRY WEIGHT) FOR INTERNATIONAL STANDARD SOIL AND VEGETATION MATERIALS

Standard	Type	Al wt%	Fe wt%	Ca wt%	Mg wt%	Mn µg/g	Cu µg/g	Ni µg/g	Zn µg/g	Se µg/g	Total I µg/g
GBW07309	Soil	5.99	3.49	4.19	1.51	622	37.2	26.5	79.1		
GBW07309	Soil	5.96	3.65	4.52	1.50	644	39.6	26.9	82.9		
Standard Value		*5.6±0.08*	*3.4±0.08*	*3.82±0.10*	*1.44±0.05*	*620±30*	*32±3*	*32±4*	*78±5*		
GBW07401	Soil									0.14	1.59
GBW07401	Soil									0.17	1.80
GBW07401	Soil										1.32
GBW07401	Soil										1.71
GBW07401	Soil										1.75
GBW07401	Soil										1.59
GBW07401	Soil										1.23
GBW07401	Soil										1.34
GBW07401	Soil										1.67
GBW07401	Soil										1.87
Standard Value										*0.14±0.04*	*1.9±0.2*
GBW07402	Soil									0.19	1.42
GBW07402	Soil									0.17	1.54
Standard Value										*0.16±0.04*	*1.8±0.2*
GBW07505	Soil										4.40
GBW07505	Soil										3.86
GBW07505	Soil										3.88
GBW07505	Soil										3.69
GBW07505	Soil										3.65
GBW07505	Soil										3.53
GBW07505	Soil										3.83
Standard Value											*3.8±0.5*
SRM1573a	Tomato Leaves										0.3097
SRM1573a	Tomato Leaves										0.3181
SRM1573a	Tomato Leaves										0.3083
SRM1573a	Tomato Leaves										0.3082
SRM1573a	Tomato Leaves										0.3047
SRM1573a	Tomato Leaves										0.3163
SRM1573a	Tomato Leaves										0.3115
SRM1573a	Tomato Leaves										0.3087
SRM1573a	Tomato Leaves										0.3108
SRM1573a	Tomato Leaves										0.3091
Standard Value											*0.85*

3.4 RESULTS

All geochemical analyses are listed as tables in Appendices B - D. In this section the data are presented as graphs and statistical tables, classified according to the three study areas to aid data interpretation.

3.4.1 Soil

3.4.1.1 PH

As the box and whisker plots (Figures 3.1 and 3.2) and Table 3.6 show, soil pH is neutral to alkaline across the three study areas (range pH 7.7 – 8.4). These results are consistent with the arid desert environment. AC148 and Kuqa soils average around pH 8.0 (median pH 7.9 and pH 8.0 respectively). Soils from the Wushi are slightly more alkaline (median pH 8.1) (Figure 3.1) largely due to the presence of higher pH soils in Daqiao (median pH 8.2) (Figure 3.2). Soil samples collected along the River Tuogishan are not shown on the box and whisker plots but summary statistics are listed in Table 3.7. These soils are very alkaline ranging from pH 8.2 to 9.4.

3.4.1.2 LOSS-ON-IGNITION (LOI) AND TOTAL ORGANIC CARBON (TOC)

TOC was determined on a selection of samples from the three study areas to assess the relationship between TOC and LOI as an indicator of organic matter (OM) content. Assuming that TOC generally accounts for 58% of the organic matter in soils, the OM content can be calculated by multiplying the TOC values by 100/58.

The TOC and OM values determined in soil samples are shown in Figure 3.3. The LOI values are slightly higher than the TOC and OM contents and OM accounts for 41-76% of the LOI in the soils. The disparity between OM content and LOI is probably due to the loss of water from clay minerals during ignition. LOI can be used as an estimate of OM content in sandy soils but may be up to twice the OM content in heavy textured soils because clays and sesquioxides lose ‘structural’ water between temperatures of 100 - 500 °C. Soil moisture determinations at 105 °C indicate average water contents of up to 1.6%.

Despite the disparity, LOI values correlate closely (R^2= 0.821) with the TOC and OM values (Figure 3.3) and for the purposes of this study, LOI will be used as an indicator of OM content.

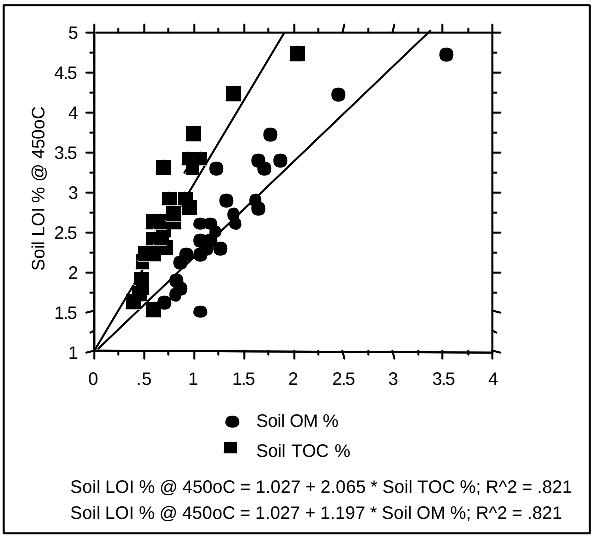


Figure 3.3 Comparison between total organic carbon, loss on ignition and organic matter content in Xinjiang soils.

The results for LOI are generally low indicating soils poor in OM. Median values for AC148, Kuqa and Wushi are 2.50, 2.20 and 2.80% respectively (Table 3.6). Soils collected from the banks of the River Tuogishan have even lower OM contents (median LOI 1.0%, Table 3.7) than the cultivated soils of the Wushi area. This is to be expected as these soils comprise coarse river sediment material.

The box and whisker plot of village LOI% (Figure 3.2) shows that there is within village variability especially in Village 3 of Commune 148. The broad range in LOI values from the same village can be attributed to variations in soil type and agricultural practices. Despite these variations, soils from all three areas have broadly similar LOI% and TOC% results (Figure 3.1), however, on average (median values) soils in the Wushi area have higher TOC hence OM contents (Table 3.6).

3.4.1.3 CATION EXCHANGE CAPACITY (CEC)

The CEC of soils in the AC148 area varies considerably between villages (Figure 3.2) reflecting different soil types. CEC in soils in the Kuqa and Wushi areas are broadly similar (ranges 3.4 – 12.10 and 5.6 – 12.70 meq/100g respectively) however, CEC in AC148 soils is generally higher (range 4.9 – 22.10) than in the other two areas with the exception of Village 21 (Figures 3.1 and 3.2 and Table 3.6). The difference in the CEC between AC148 soils and the other two study areas is considered in more detail in terms of major element chemistry in the following sections.

TABLE 3.6 SUMMARY STATISTICS FOR DETERMINANTS IN SOIL, WATER, WHEAT AND CABBAGE SAMPLES FROM THE THREE STUDY AREAS

	Water															
	I µg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	Br mg/l	NO_2 mg/l	F mg/l	pH	Temp °C	Conductivity µS	Alkalinity mg/l CaCO3	Corrected Eh mV
Whole Dataset																
Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Minimum	0.10	2.20	0.43	20.60	0.33	8.58	10.10	0.20	0.02	0.01	0.10	7.30	18.30	536.00	81.00	267.00
Maximum	100.00	174.00	112.71	1023.76	11.50	993.00	1150.00	15.00	0.06	0.72	1.93	9.24	25.60	5430.00	332.00	336.00
Geom. Mean	6.01	34.50	13.74	99.27	2.80	73.43	119.82	1.83	0.03	0.02	0.42	8.06	22.18	1029.14	165.58	296.28
Median	3.25	57.60	30.40	115.00	6.41	64.80	112.00	3.30	0.02	0.01	0.34	7.88	22.20	1080.00	147.00	288.60
Mean	30.10	65.76	37.26	159.34	4.81	142.67	207.94	4.97	0.03	0.07	0.61	8.09	22.27	1309.93	181.17	297.17
Area 1 - 148																
Count	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum	78.00	2.20	0.43	108.00	0.33	8.58	10.10	0.20	0.02	0.01	0.24	8.50	23.40	536.00	121.00	288.60
Maximum	100.00	44.98	112.71	1023.76	2.49	993.00	1150.00	0.30	0.03	0.72	1.13	9.24	25.60	5430.00	132.00	336.00
Geom. Mean	88.25	5.65	1.56	181.51	0.54	52.99	70.70	0.22	0.02	0.03	0.80	8.94	24.29	900.84	127.74	322.62
Median	92.25	4.03	0.59	122.00	0.33	33.90	50.60	0.20	0.02	0.02	1.10	9.02	24.40	580.00	129.00	329.00
Mean	88.65	11.79	22.98	299.15	0.80	222.48	264.14	0.22	0.02	0.16	0.91	8.94	24.30	1546.60	127.80	323.12
Area 2 - Kuqa																
Count	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum	2.40	38.20	23.20	48.70	6.41	64.80	84.50	0.70	0.02	0.01	0.10	7.30	18.30	625.00	81.00	267.00
Maximum	4.05	174.00	60.30	139.00	11.50	171.00	300.00	15.00	0.05	0.10	1.93	8.00	21.40	1830.00	332.00	286.00
Geom. Mean	3.15	83.35	37.41	101.58	7.76	125.16	182.14	4.30	0.03	0.01	0.38	7.66	19.94	1198.65	164.31	279.13
Median	3.15	90.60	30.40	120.00	6.69	141.00	208.00	4.81	0.03	0.01	0.32	7.76	19.80	1182.00	168.00	281.00
Mean	3.19	95.28	40.44	107.94	7.97	131.76	197.50	7.07	0.03	0.03	0.66	7.66	19.98	1282.00	191.80	279.20
Area 3 - Wushi																
Count	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum	0.10	54.00	22.70	20.60	2.70	31.70	68.60	3.30	0.02	0.01	0.12	7.36	21.70	550.00	147.00	270.00
Maximum	3.70	113.00	73.50	164.00	7.97	174.00	301.00	13.50	0.06	0.07	0.51	8.36	24.10	1840.00	315.00	307.00
Geom. Mean	0.78	87.24	44.54	53.06	5.27	59.70	133.59	6.59	0.03	0.01	0.24	7.65	22.53	1009.46	216.30	288.83
Median	0.95	95.80	53.80	43.90	6.41	61.80	112.00	5.00	0.02	0.01	0.21	7.48	22.20	1080.00	224.50	289.00
Mean	1.45	90.22	48.36	70.92	5.65	73.78	162.18	7.63	0.03	0.02	0.27	7.66	22.54	1101.20	223.90	289.20

Table 3.6 cont.

	Soil																Wheat I µg/100g DW	Cabbage I µg/100g DW
	Al wt%	Fe wt%	Ca wt%	Mg wt%	Mn µg/g	Cu µg/g	Ni µg/g	Zn µg/g	Se µg/g	Total I µg/g	WSol I µg/g	CEC meq/100g	% TOC	% Moisture @ 105°C	Soil pH	LOI @ 450°C		
Whole Dataset																		
Count	76	76	76	76	76	76	76	76	28	76	76	28	28	28	76	76	75	44
Minimum	4.43	1.84	2.49	1.11	464.00	13.00	14.00	49.00	0.14	0.30	0.012	3.40	0.41	0.40	7.70	1.50	3.17	3.55
Maximum	7.45	3.90	13.75	2.72	775.00	53.00	30.00	91.00	0.51	3.90	0.040	22.10	2.05	7.40	8.40	4.70	38.87	23.46
Geom. Mean	5.74	2.81	7.62	1.70	613.53	26.71	21.97	71.12	0.26	0.92	0.015	8.46	0.74	1.26	7.99	2.44	13.08	10.52
Median	5.65	2.83	9.80	1.60	614.00	27.00	22.00	71.50	0.25	0.98	0.012	8.85	0.72	1.05	8.00	2.50	12.88	10.51
Mean	5.78	2.82	8.48	1.75	616.11	27.19	22.15	71.56	0.27	1.05	0.015	9.51	0.79	1.62	7.99	2.51	14.69	11.32
Area 1 - 148																		
Count	25	25	25	25	25	25	25	25	9	25	25	9	9	9	25	25	25	14
Minimum	5.28	2.52	2.49	1.11	499.00	13.00	18.00	60.00	0.14	0.30	0.012	4.90	0.41	1.00	7.70	1.60	5.66	5.86
Maximum	7.45	3.90	5.53	1.64	775.00	36.00	30.00	91.00	0.30	3.90	0.030	22.10	2.05	3.50	8.20	4.70	31.40	16.19
Geom. Mean	6.48	2.98	3.87	1.34	618.28	26.31	21.63	71.31	0.20	0.91	0.014	12.63	0.77	1.77	7.91	2.45	14.22	10.60
Median	6.66	2.95	3.99	1.32	611.00	26.31	21.00	70.00	0.20	1.05	0.012	14.90	0.71	1.70	7.90	2.50	13.36	10.67
Mean	6.51	3.00	3.98	1.32	620.78	26.00	21.85	71.79	0.20	1.11	0.015	13.74	0.87	1.89	7.91	2.53	15.72	10.94
Area 2 - Kuqa																		
Count	25	25	25	25	25	25	25	25	9	25	25	9	9	9	25	25	25	15
Minimum	4.43	1.84	8.64	1.34	464.00	16.00	14.00	49.00	0.16	0.30	0.012	3.40	0.47	0.40	7.90	1.50	3.17	3.55
Maximum	6.04	3.01	13.75	2.40	696.00	53.00	26.00	78.25	0.35	2.93	0.030	12.10	0.94	0.90	8.20	2.90	38.87	23.46
Geom. Mean	5.44	2.63	10.63	1.72	625.05	26.62	21.71	66.70	0.24	1.06	0.015	5.36	0.60	0.74	7.99	2.10	11.98	10.56
Median	5.61	2.77	9.82	1.57	654.00	27.00	23.00	69.00	0.24	1.00	0.012	5.00	0.62	0.80	8.00	2.20	12.88	10.76
Mean	5.46	2.65	10.78	1.76	629.13	27.26	21.94	67.13	0.24	1.16	0.015	5.73	0.62	0.76	7.99	2.13	14.07	11.71
Area 3 - Wushi																		
Count	26	26	26	26	26	26	26	26	10	26	26	10	10	10	26	26	25	15
Minimum	4.87	2.29	9.62	1.76	533.00	22.00	18.00	68.00	0.24	0.30	0.012	5.60	0.66	0.60	7.80	1.80	5.12	6.42
Maximum	6.06	3.21	11.83	2.72	677.00	46.00	27.00	88.00	0.51	1.73	0.040	12.70	1.08	7.40	8.40	3.70	36.25	21.22
Geom. Mean	5.39	2.81	10.59	2.13	598.19	27.20	22.58	75.44	0.35	0.80	0.015	8.91	0.87	1.50	8.07	2.82	13.14	10.40
Median	5.40	2.82	10.64	2.05	595.50	27.00	22.88	75.00	0.32	0.84	0.012	9.15	0.89	1.15	8.10	2.80	12.16	9.35
Mean	5.39	2.82	10.61	2.15	599.11	27.56	22.64	75.62	0.36	0.89	0.016	9.09	0.88	2.15	8.08	2.86	14.28	11.28

WSol = Water Soluble　　Geom. Mean = Geometric Mean　　DW = dry weight

TABLE 3.7 SUMMARY STATISTICS FOR DETERMINANTS IN RIVER TUOGISHAN SOIL AND WATER SAMPLES, WUSHI STUDY AREA

	Soil											
	Al wt%	**Fe wt%**	**Ca wt%**	**Mg wt%**	**Mn µg/g**	**Cu µg/g**	**Ni µg/g**	**Zn µg/g**	**Total I µg/g**	**WSol I µg/g**	**pH**	**LOI %**
Count	7	7	7	7	7	7	7	7	7	7	7	7
Minimum	3.87	1.92	9.53	1.36	417.00	20.00	15.00	44.00	0.30	0.012	8.20	0.50
Maximum	5.36	2.87	12.86	1.98	621.00	31.00	24.00	69.00	2.11	0.030	9.40	2.70
Geom. Mean	4.44	2.24	10.96	1.60	501.14	22.83	17.37	51.24	0.67	0.017	8.53	1.09
Median	4.46	2.18	10.85	1.52	498.00	21.00	17.00	51.00	0.57	0.012	8.30	1.00
Mean	4.46	2.25	11.00	1.62	504.86	23.14	17.57	51.71	0.82	0.018	8.54	1.31

	Water															
	I µg/l	**Ca mg/l**	**Mg mg/l**	**Na mg/l**	**K mg/l**	**Cl mg/l**	**SO_4 mg/l**	**NO_3 mg/l**	**Br mg/l**	**NO_2 mg/l**	**F mg/l**	**pH**	**Temp ^oC**	**Conductivity µS**	**Alkalinity mg/l CaCO3**	**Corrected Eh mV**
Count	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Minimum	0.10	45.40	19.60	14.90	2.29	21.30	66.40	2.35	0.02	0.01	0.07	8.06	21.70	476.00	111.00	272.00
Maximum	1.80	79.60	52.30	64.40	5.42	67.10	169.00	5.27	0.02	0.05	0.45	8.52	22.70	1014.00	255.00	299.00
Geom. Mean	0.58	54.60	27.61	26.64	3.04	35.67	87.96	4.51	0.02	0.02	0.15	8.29	22.14	600.42	137.32	283.28
Median	0.65	47.50	22.40	20.00	2.72	36.50	69.50	5.02	0.02	0.01	0.13	8.33	22.00	510.00	123.00	281.00
Mean	0.81	56.13	29.54	31.34	3.21	39.00	94.07	4.65	0.02	0.02	0.18	8.29	22.14	627.43	143.43	283.43

WSol = Water Soluble   Geom. Mean = Geometric Mean

3.4.1.4 SOIL COLOUR AND TEXTURE

The majority of soils in the study areas are within Munsell Colour Chart categories light grey, light olive grey and light yellowish brown (Figure 3.2). Soils in the AC148 area are also classified as brown or grey brown and in the Kuqa area as pale and yellowish brown. Soil texture in the three study areas is also very homogeneous with the majority of soils classified as clay-silt (Figure 3.2). In contrast, soils collected from the banks of the River Tuogishan in the Wushi area comprise coarser sandy material (Appendix B1).

3.4.1.5 MAJOR AND TRACE ELEMENT CHEMISTRY

Aluminium and Fe contents in AC148 soils are broadly consistent in all villages (Figure 3.2) and are markedly higher than in the other two areas (Figures 3.1 and 3.2 and Table 3.6) (Median values, AC148, Al 6.66 wt%, Fe 2.95 wt%; Kuqa Al 5.61 wt%, Fe 2.77 wt% and Wushi Al 5.40 wt%, Fe 2.82 wt%). Conversely all village Ca and Mg soil contents in the Kuqa and Wushi villages are higher than AC148 values (Figure 3.2). This suggests greater dominance of carbonate parent materials in soils in the Kuqa and Wushi study areas and higher clay and Al and Fe oxyhydroxide contents in soils of the AC148 area.

Trace element (Mn, Cu, Ni, and Zn) concentrations in soils from the three study areas are broadly similar with the exception of Sandaqiao Village in the Kuqa area. Soils from this village have low Fe and Al oxyhydroxide, clay and OM contents compared to the other soils in the study (Figure 3.2) and as a consequence, the CEC of these soils is also low restricting the ability of the soil to bind and retain the other trace elements Mn, Cu, Ni and Zn.

Selenium concentrations determined on a sub-set of soils from each of the study areas are notably higher in the Wushi soils (median 0.32 µg/g) than the other two regions (median AC148 0.20 µg/g, Kuqa 0.24 µg/g) probably reflecting the higher pH, Ca and Mg content of soils in the Wushi area as alkaline conditions enhance the mobility of Se in the environment.

3.4.1.6 SOIL IODINE

Soil total iodine concentrations range from 0.30 to 3.90 µg/g (median 0.98 µg/g) across the study areas. These values are very low compared to most soils. Fuge and Johnson (1986) list results for iodine in soils from many parts of the world - an average value of 4 - 8 µg/g is suggested. Vinogradov (1959) cites an average for iodine in soils of 5 µg/g. The total iodine concentrations in Xinjiang soils are lower than soils in Sri Lanka investigated during previous IDD studies (range 0.13 – 10.00 µg/g, mean 3.11 µg/g) (Fordyce et al., 2000). These results confirm that the Xinjiang area is an iodine-poor environment.

Soil total iodine contents in the three study areas are broadly similar with the exception of Village 3 in the AC148 area. Soils in this village show the broadest range of total iodine concentrations (0.5 to 3.9 µg/g). These soils also have widely ranging OM contents (as shown by LOI and TOC values, Figures 3.1 and 3.2) and higher soil total iodine contents in this village are likely to reflect the greater OM content of the soils. In general, soil total iodine contents decrease in the order AC148 (range 0.3 – 3.9, median 1.05 µg/g) > Kuqa (range 0.3 – 2.93, median 1.0 µg/g) > Wushi (range 0.3 – 1.73, median 0.84 µg/g). On the basis of this evidence, the iodine-dripping programme has not significantly increased the total iodine content of the soils in the Wushi area above the natural contents of non-dripped areas.

The total iodine contents of seven soil samples collected along the banks of the River Tuogishan in Wushi District (Study Area 3) to assess the distribution of iodine in the environment of the dripped study area are shown in Figure 3.4. Soil total iodine contents show no consistent relationship with proximity to the iodine dripping sites (River flows from west to east).

Soil water soluble iodine contents are very low (range 0.012 – 0.040 µg/l, median 0.012 µg/l), close to the detection limit in all three study areas, however, the Wushi (dripped) area has a higher proportion of samples above the detection limit giving some evidence that levels of water-soluble (bioavailable) iodine are higher in this area. The iodine-dripping programme carried out by the XIDP in 1999 was shown to increase the water-soluble or bioavailable portion of iodine in the local soils by approximately ten-fold (Table 3.8). However, results of the present study carried out in 2000 suggest that iodine applied in this way was not retained in the soil in the longer term as the levels reported are comparable to the pre-dripping soil status (Table 3.8). This is probably because the soils are very sandy, with low clay and organic matter contents namely; there is very little material to retain iodine in the soil.

Soil total and water soluble iodine contents show few significant (95% confidence level) correlations with other soil parameters, however, the correlation between total iodine and Mn may indicate that iodine is held in Mn oxides in the soils (Table 3.9). Interestingly, soil water-soluble iodine contents do not correlate significantly with soil total iodine levels; this may be due to the fact that the majority of soil water-soluble values were below the detection limit.

TABLE 3.8 AVERAGE SOIL WATER SOLUBLE I CONTENTS IN VILLAGES IN WUSHI DISTRICT (STUDY AREA 3) FROM THE PRESENT STUDY COMPARED TO THE IODINE DRIPPING STUDY CARRIED OUT BY (SHAOHUA AND DELONG, 2000)

Village	**No of Samples**	**Soil Water Soluble Iodine (µg/g)** Pre-dripping Average 1999	**Post-dripping Average 1999**	**Present Study Median 2000**
Daqiao	5	0.018	0.124	0.012
Wushi Town	5	0.018	0.109	0.018
Aheya	5	0.023	0.105	0.012
Autebeixi	5	0.017	0.113	0.016
Yimamu	5	0.013	0.099	0.015

TABLE 3.9 SPEARMAN RANK CORRELATION MATRIX FOR SOIL PARAMETERS FROM THE THREE STUDY AREAS

	Al	Fe	Ca	Mg	Mn	Cu	Ni	Zn	Total I	WSol I	OM	pH	Se*	CEC*	TOC*
Al													**-0.625**	**0.426**	-0.053
Fe	**0.719**												**-0.418**	**0.545**	0.192
Ca	**-0.716**	**-0.391**											**0.466**	**-0.547**	0.035
Mg	**-0.628**	**-0.194**	**0.884**										**0.659**	-0.201	0.293
Mn	**0.508**	**0.582**	-0.128	-0.104									**-0.397**	0.025	-0.004
Cu	**0.366**	**0.492**	-0.135	-0.013	**0.344**								0.023	**0.549**	**0.370**
Ni	0.171	**0.476**	0.129	**0.277**	**0.630**	**0.359**							0.008	-0.019	-0.055
Zn	**0.270**	**0.681**	0.047	**0.303**	**0.380**	**0.564**	**0.501**						0.118	**0.689**	**0.685**
I	0.174	0.155	-0.021	-0.104	**0.409**	0.006	**0.247**	0.084					-0.253	-0.024	0.051
WSol I	-0.029	-0.008	0.101	0.062	-0.032	0.034	-0.052	0.087	-0.038				0.212	0.150	0.193
OM	-0.046	0.072	0.016	0.179	0.040	0.040	0.007	**0.262**	-0.033	-0.009			**0.509**	**0.624**	**1.000**
pH	**-0.431**	-0.103	**0.524**	**0.600**	-0.013	**-0.207**	**0.273**	0.046	0.047	0.150	0.056		**0.331**	-0.148	0.067
LOI	0.118	**0.366**	-0.005	**0.260**	0.047	**0.398**	0.100	**0.688**	-0.075	0.007	**0.453**	0.047	**0.337**	**0.769**	**0.914**
Se*														0.019	**0.509**
CEC*															**0.624**

n = 76 * n = 28 Significant correlations 95% confidence level in bold text r76 = 0.185 r28 = 0.317 (Koch and Link, 1970)

TABLE 3.11 VILLAGE MEDIAN IODINE CONTENTS IN SOIL, WATER, WHEAT AND CABBAGE SAMPLES

Area	**Village**	**No.**	**Soil Total I µg/g**	**Soil WSol I µg/g**	**No.**	**Wheat I µg/100g DW**	**No.**	**Cabbage I µg/100g DW**	**No.**	**Water I µg/l**
148	Village 2	5	1.17	0.012	5	10.70	3	10.66	1	92.25
148	Village 21	5	1.14	0.012	5	17.14	3	10.35	1	100.00
148	Village 3	5	1.16	0.020	5	10.59	2	11.86	1	93.00
148	Village 4	5	0.67	0.020	5	18.20	3	9.49	1	80.00
148	Village 6	5	0.77	0.012	5	14.06	3	15.53	1	78.00
Kuqa	Qiman	5	0.99	0.020	5	13.22	3	7.17	1	3.09
Kuqa	Sandaqiao	5	0.93	0.012	5	10.12	3	7.76	1	3.15
Kuqa	Waqiao	5	1.16	0.012	5	8.03	3	11.84	1	4.05
Kuqa	Wuzun	5	1.00	0.012	5	11.26	3	17.86	1	2.40
Kuqa	Yaha	5	1.65	0.012	5	16.29	3	15.45	1	3.25
Wushi	Aheya	5	1.37	0.012	5	15.68	3	9.35	1	0.10
Wushi	Autebeixi	6	0.70	0.012	5	11.14	3	10.66	1	0.40
Wushi	Daqiao	5	0.62	0.012	5	12.14	3	7.96	1	3.70
Wushi	Wushi Town	5	0.94	0.014	5	15.26	3	8.17	1	0.95
Wushi	Yimamu	5	0.98	0.012	5	12.11	3	17.69	1	2.10

No. = No of Samples WSol = Water Soluble DW = dry weight

3.4.2 Water

3.4.2.1 Chemical Parameters

The source of drinking water samples in the three study areas is a major control on the water chemistry. Drinking water in AC148 is pumped to storage tanks from deep groundwater aquifers (60 – 370 m) where contact residency times between the water and the aquifer rock are much greater than residency times in the shallower near-surface water sources in the Kuqa and Wushi study areas. As a consequence, the pH, Eh, conductivity, F, NO_2, Cl, SO_4, Na and iodine contents of the AC148 waters are significantly higher than waters from the Kuqa and Wushi areas (Figure 3.5).

Conversely waters from the Kuqa and Wushi study areas have higher Ca, Mg and K contents probably reflecting the greater dominance of carbonate rock types in these areas and the influence of the weathering of rock forming minerals in the near-surface waters. As a result of the higher Ca and Mg contents, alkalinity is also greater in these waters than in the AC148 area (Figure 3.5). The higher NO_3 contents in waters from the Kuqa and Wushi areas probably indicate agricultural contamination (from fertiliser usage) in the near-surface environment.

3.4.2.2 Water Iodine

Iodine contents in the AC148 waters are very high (78 – 100 µg/l) compared to the other two areas (Kuqa 2.40 – 4.05 µg/l, Wushi 0.1 – 3.7µg/l) (Table 3.6). These concentrations are similar to high values reported in the Dry Zone of Sri Lanka (Fordyce et al., 2000) and at these levels, drinking water iodine will contribute significantly to dietary intake (See section 5). In the Kuqa and Wushi areas, water iodine concentrations are extremely low compared to other areas where IDD is prevalent. For example, the Wet Zone of Sri Lanka (iodine in drinking water range 3 – 24 µg/l (Fordyce et al., 2000)); northeast India (iodine in drinking water range 3 – 31.5 µg/l (Longvah and Deosthale, 1998)) and Heilongjiang Province in China (iodine in drinking water range 3 – 9 µg/l (Tan, 1989)).

The iodine contents of seven water samples collected along the River Tuogishan in Wushi District (Study Area 3) to assess the distribution of iodine in the environment of the dripped study area are shown in Figure 3.6. The three eastern-most samples collected downstream of the iodine dripping sites do contain higher iodine concentrations than samples in the west of the irrigated area. This suggests the addition of iodine to irrigation channels in the area which all drain into the River Tuogishan may have had a small effect on the river water chemistry.

3.4.3 Wheat and Cabbage Iodine

The total iodine (dry weight) content of wheat in the three study areas is broadly similar (AC148 5.66 – 31.40, Kuqa 3.17 – 38.87 and Wushi 5.12 – 36.25 µg/100g) (Table 3.6 and Figure 3.7). Cabbage iodine contents also show little variation between the three study areas (AC148 5.86 – 16.19, Kuqa 3.55 – 23.46 and Wushi 6.42 – 21.22 µg/100g) (Table 3.6 and Figure 3.7). This indicates that the iodine dripping programme in Wushi has not increased crop iodine contents compared to the non dripped areas, indeed based on median values wheat and cabbage samples from the Wushi (12.16 and 9.35 µg/100g respectively) area contain marginally less iodine than in AC148 (13.36 and 10.67 µg/100g respectively) and Kuqa (12.88 and 10.76 µg/100g respectively). As a measure of uptake of iodine from soil to crops, the ratios of wheat/soil and cabbage/soil total iodine contents are compared between the three study areas (Figure 3.7). On this basis, there is some evidence to suggest better uptake of iodine into crops in the Wushi area compared to the Kuqa area, which may be a result of more readily available iodine in Wushi soils following the dripping programme, however, the ratios of wheat/water-soluble soil iodine and cabbage/water-soluble soil iodine do not confirm this, probably because the majority of soil water-soluble iodine results were below the limit of detection.

In terms of comparison between soil and crop samples, Spearman Rank determinations show no significant (95% confidence level) correlations between iodine values in soil and wheat (based on 75 samples) which may reflect the fact that wheat samples were collected from village stores rather than directly from the fields were soils were collected (Table 3.10). However, cabbage and soil samples were collected from the same fields but show no significant correlation (based on 44 samples) between iodine contents (Table 3.10). The lack of correlations between soil water-soluble iodine and crop concentrations may be due to the number of values below the limit of detection but may also reflect the main mechanism of plant iodine uptake via volatilisation rather than the roots (See Section 5). Due to the different numbers of each sample type collected, comparisons between soil, wheat and cabbage results with water are based on village median values (Table 3.11). Village median results show no significant correlations between water iodine contents and any other sample media (Table 3.10).

Table 3.10 Spearman Rank correlation matrix for iodine contents in soil, water, wheat and cabbage

	Soil I	Soil WSol I	Wheat I	Cabbage I
Soil WSol I	#-0.04			
Wheat I	#-0.16	#0.11		
Cabbage I	~-0.08	~-0.20	*-0.15	
Water I	*0.11	*0.26	*0.00	*0.11

* Based on village median results r15 = 0.441

r75 = 0.185 ~ r44 = 0.235 (Koch and Link, 1970)

Significant correlations 95% confidence level in bold text

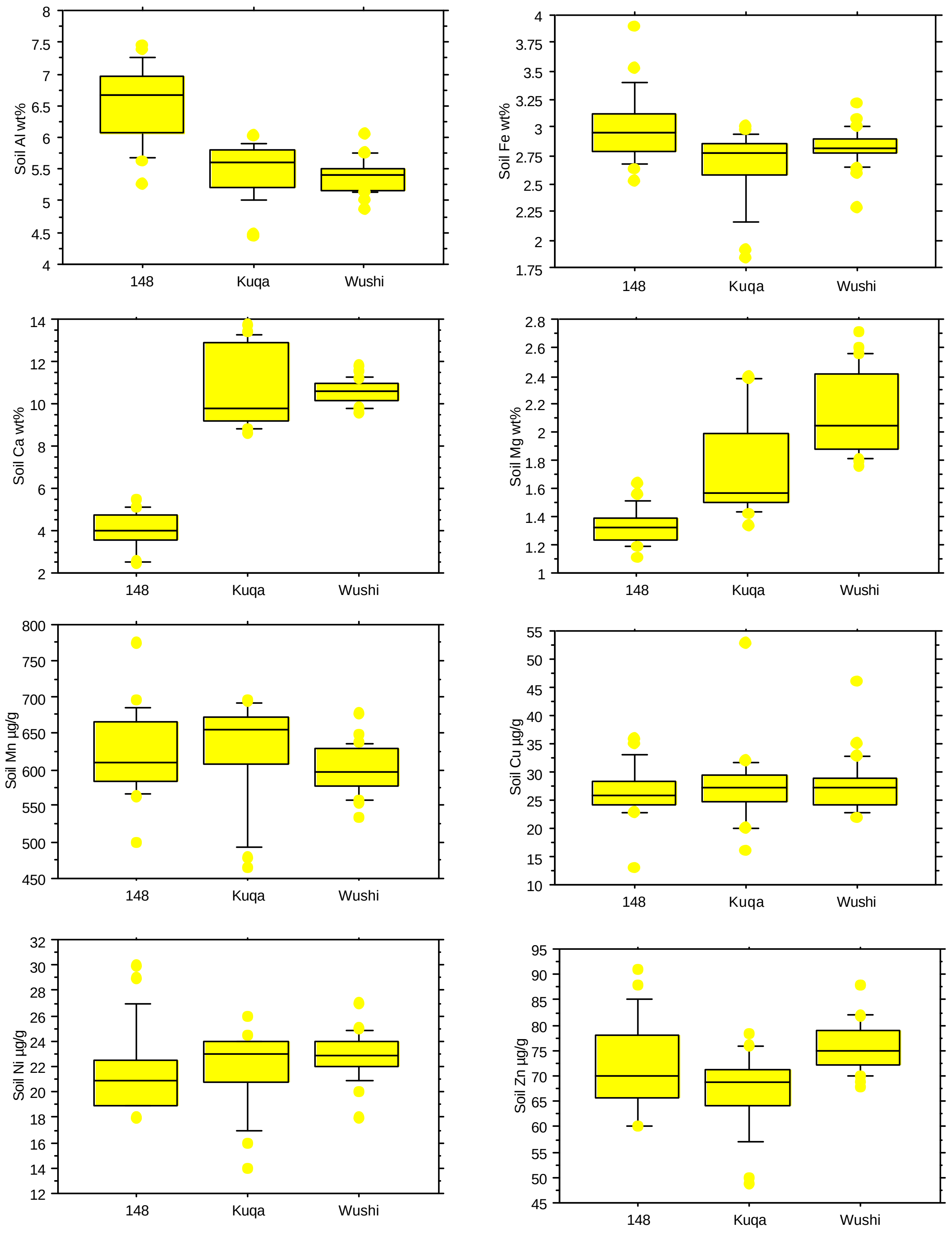


Figure 3.1a Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of soil parameter distributions classified by study area.

(148 = no iodine dripping/ low IDD n = 25; Kuqa = no iodine dripping/ high IDD n = 24; Wushi = iodine dripping/ high IDD n = 26)

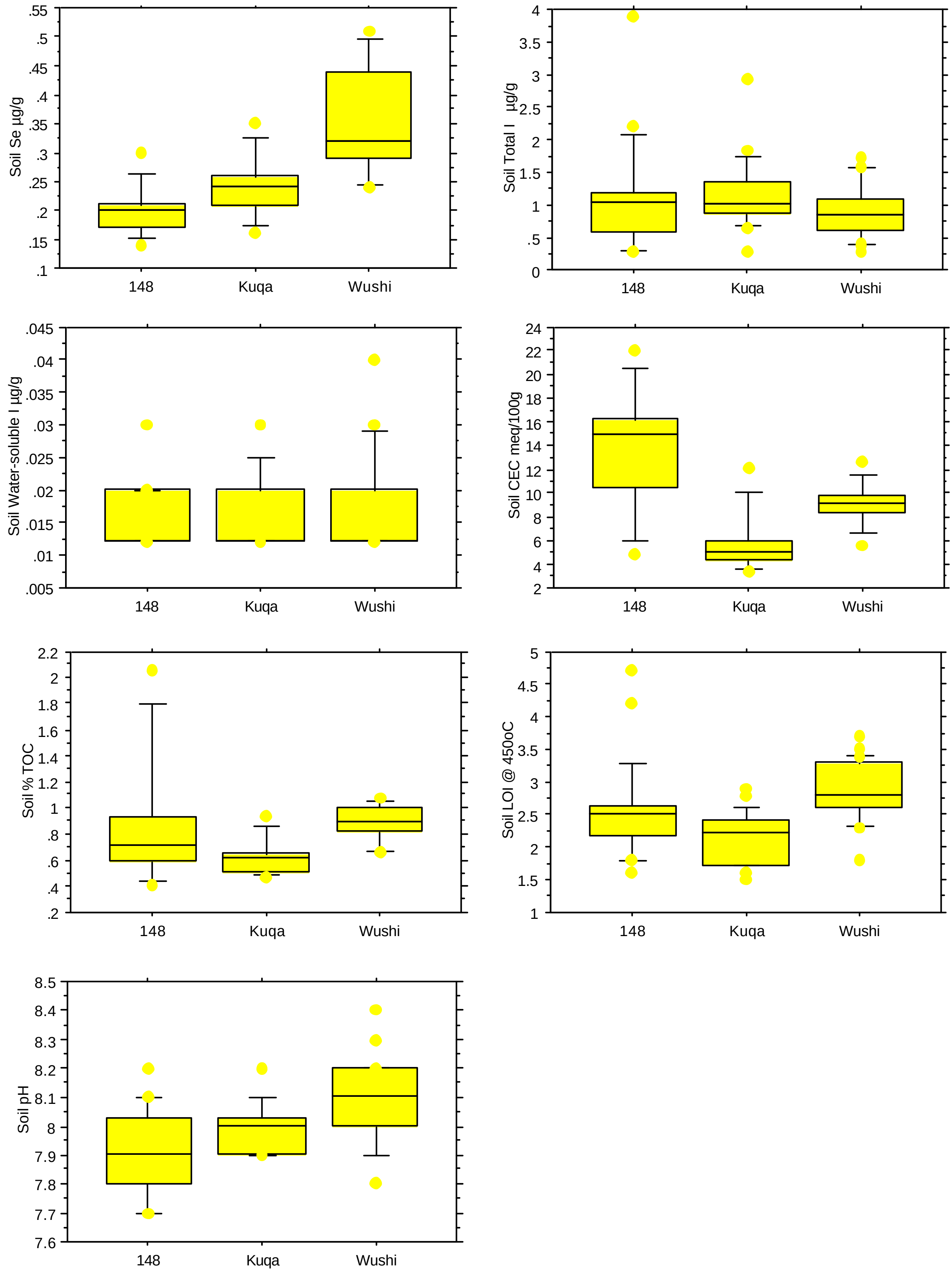


Figure 3.1b Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of soil parameter distributions classified by study area.

(148 = no iodine dripping/ low IDD n = 25 except CEC, Se, TOC n = 9; Kuqa = no iodine dripping/ high IDD n = 24 except CEC, Se and TOC n = 9; Wushi = iodine dripping/ high IDD n = 26 except CEC, Se and TOC, n = 10)

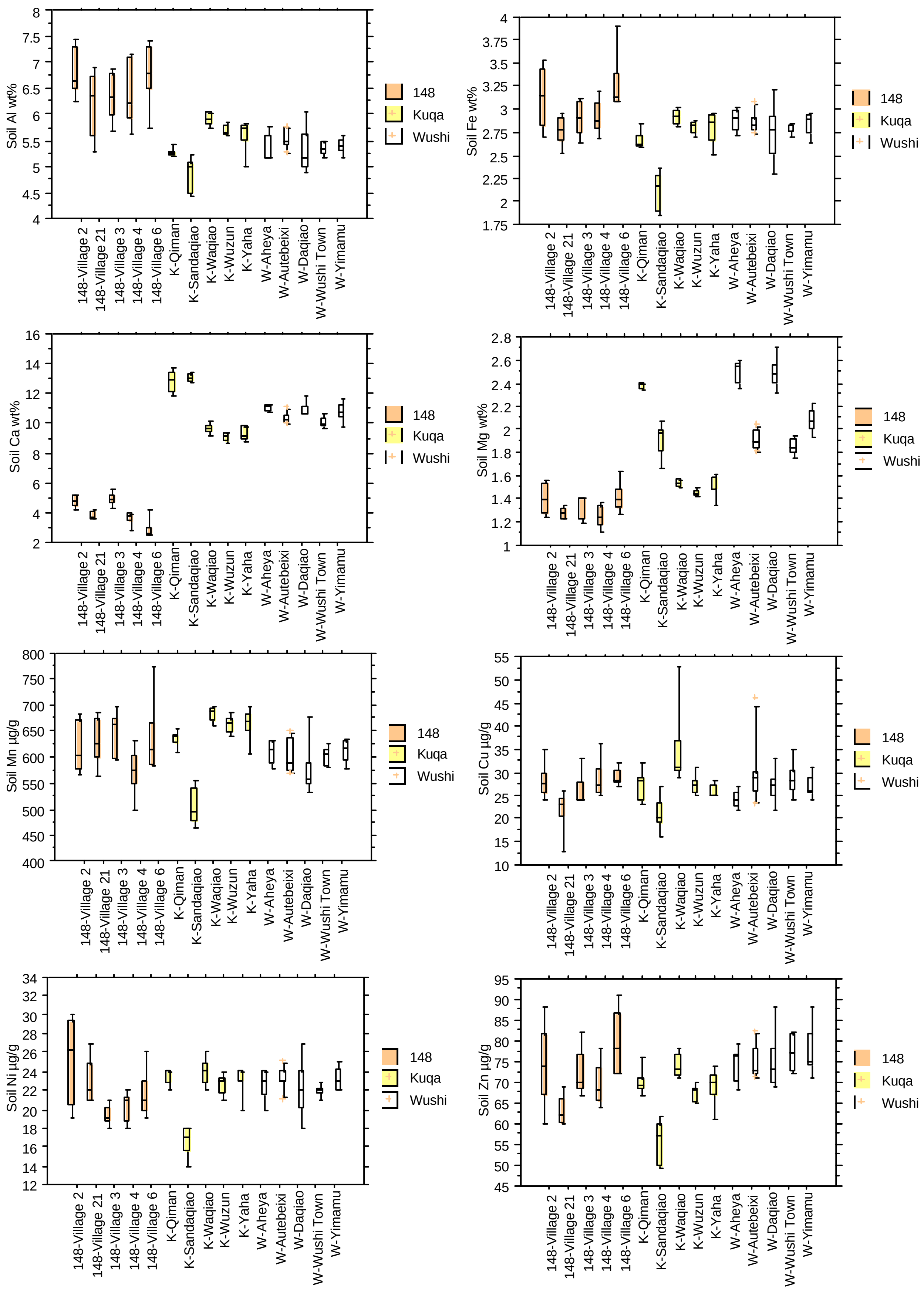


Figure 3.2a Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of soil parameter distributions classified by village.

(148 = no iodine dripping/ low IDD n = 5; Kuqa = no iodine dripping/ high IDD n = 5; Wushi = iodine dripping/ high IDD n = 5)

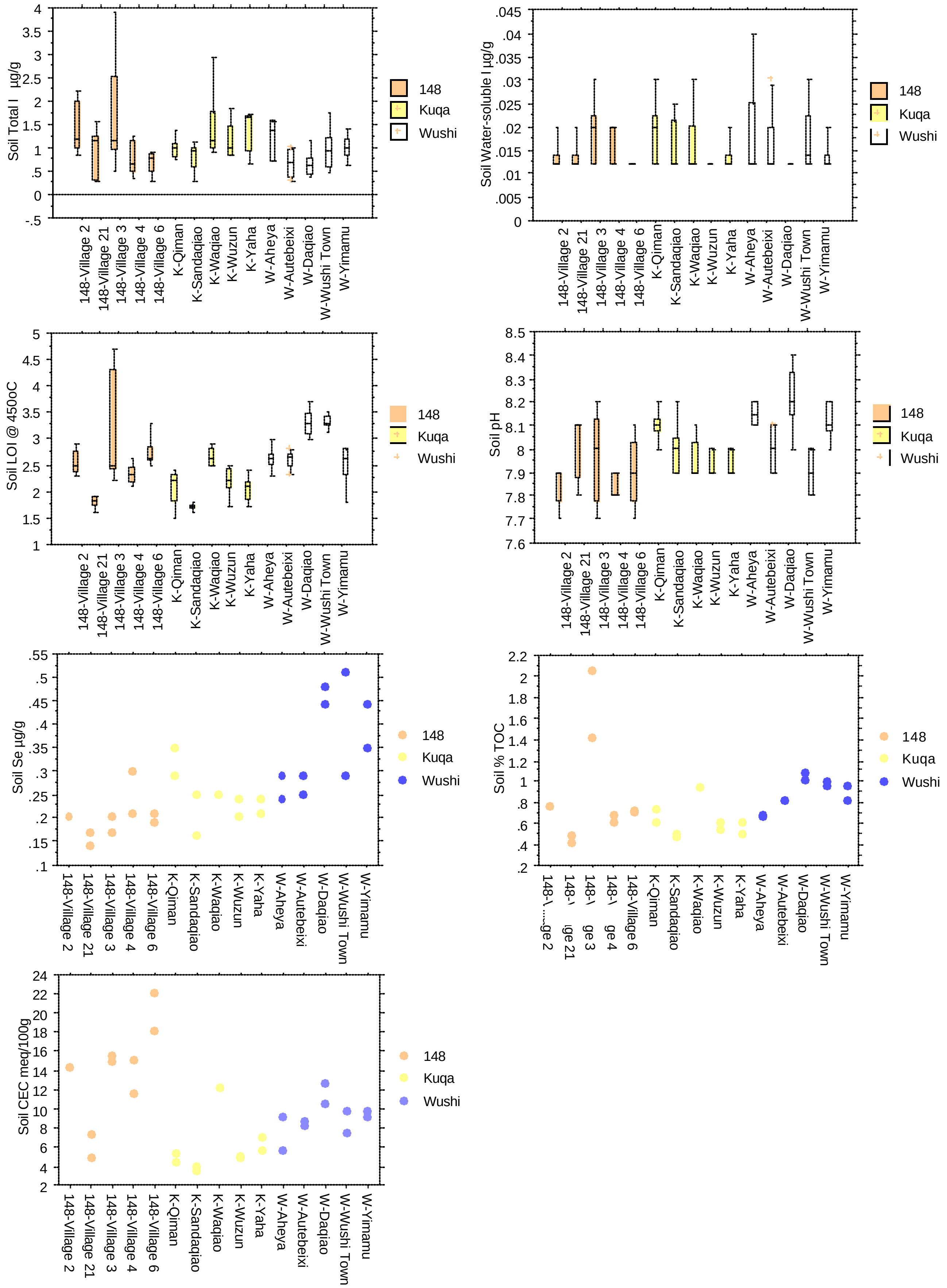


Figure 3.2b Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of soil parameter distributions classified by village.

(148 = no iodine dripping/ low IDD n = 5 except Se, CEC and TOC n = 2; Kuqa = no iodine dripping/ high IDD n = 5 except Se, CEC and TOC n = 2; Wushi = iodine dripping/ high IDD n = 5, except Se, CEC and TOC n = 2)

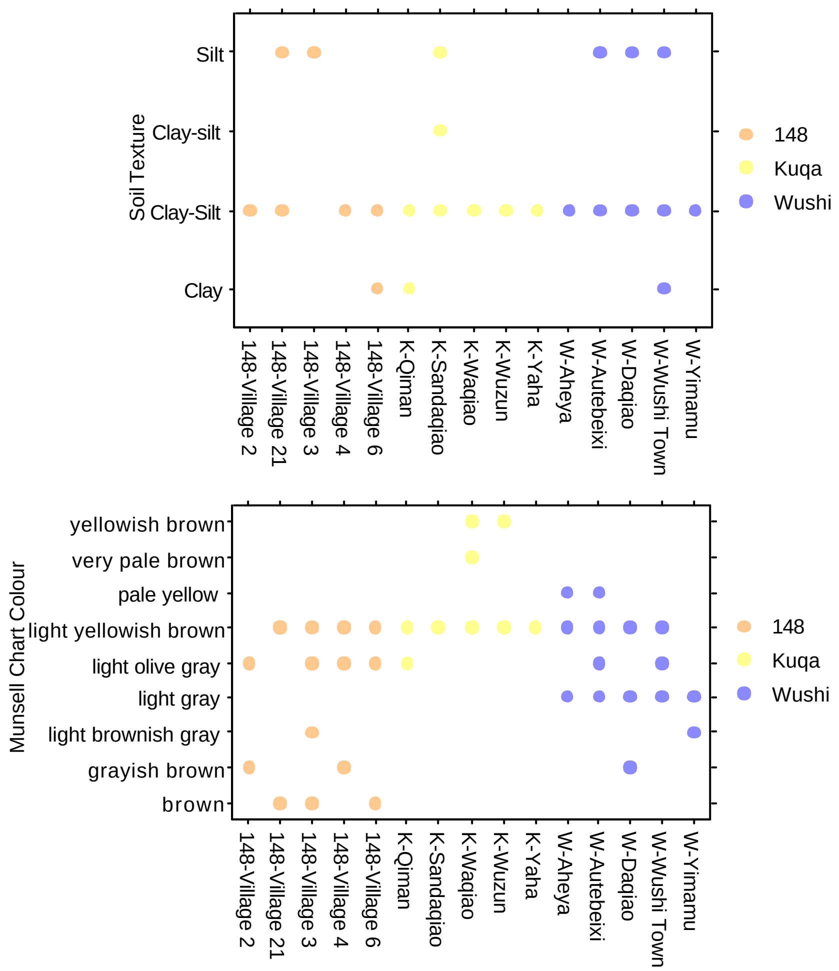
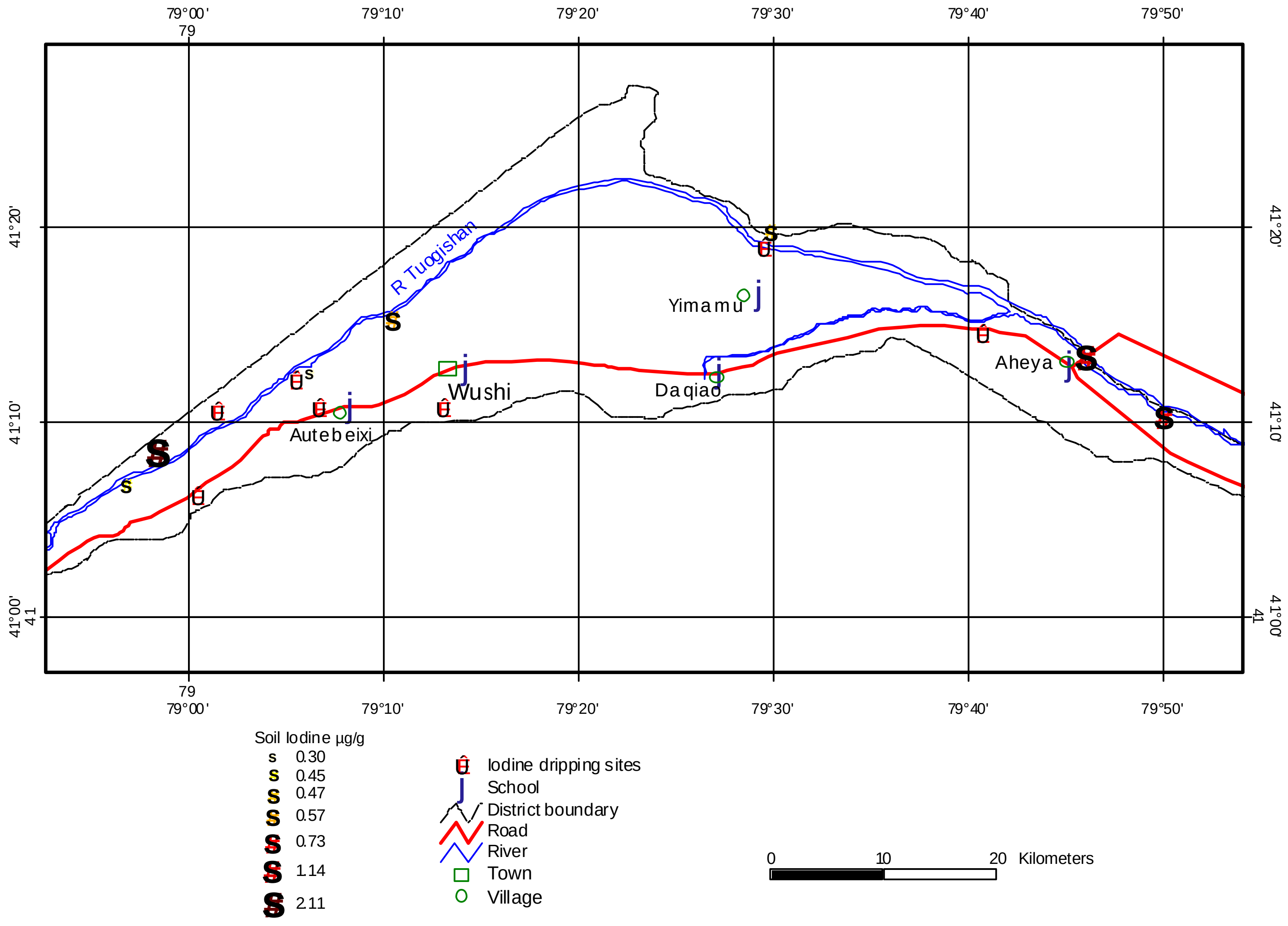


Figure 3.2c Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of soil Munsell colour and texture classified by village.

(148 = no iodine dripping/ low IDD n = 5; Kuqa = no iodine dripping/ high IDD n = 5; Wushi = iodine dripping/ high IDD n = 5)

Figure 3.4 Map of total iodine concentrations in soil samples collected on the banks of the River Tuogishan in Wushi District (Study Area 3).

(River Tuogishan flows from west to east)



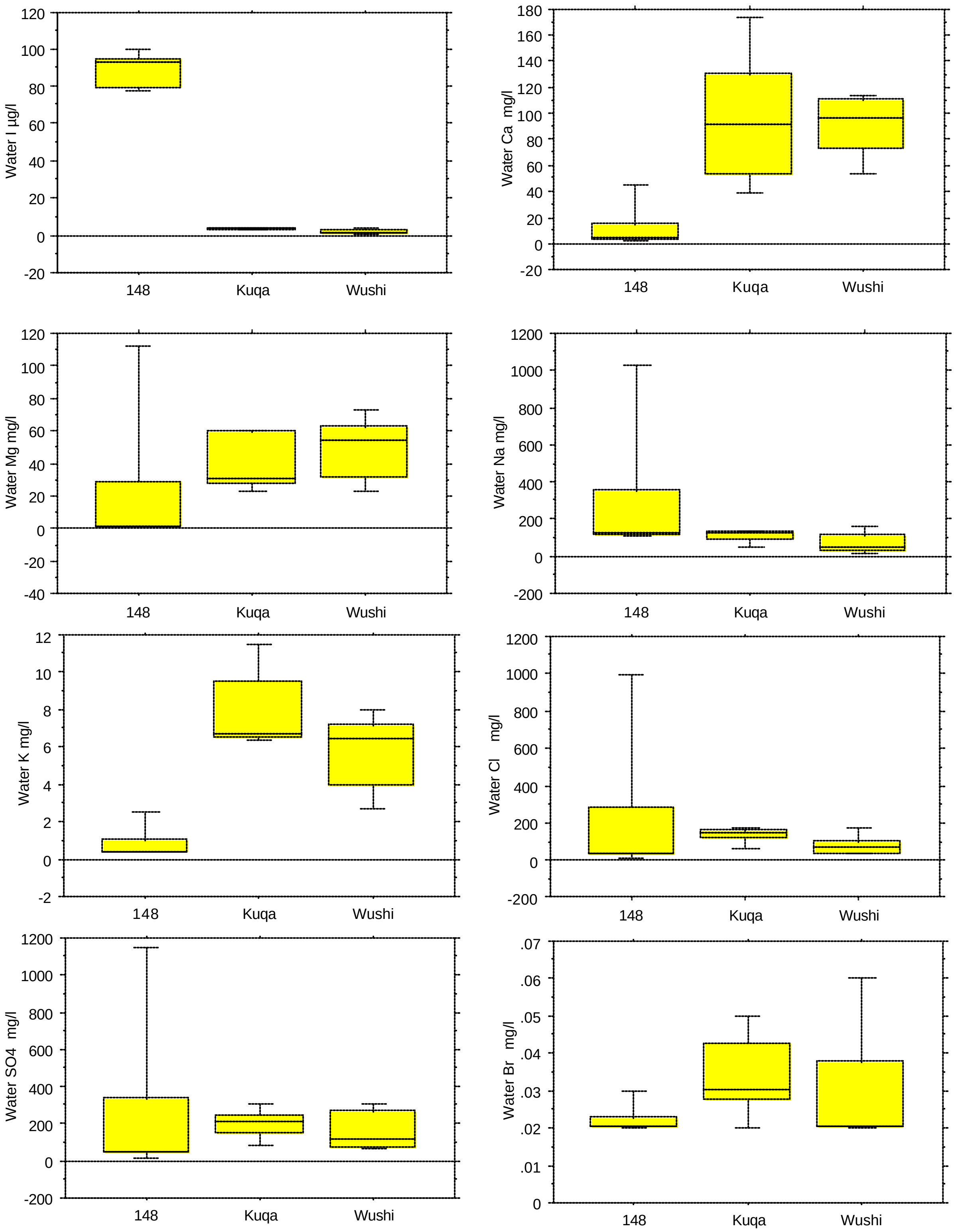


Figure 3.5a Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of water parameter distributions classified by study area.

(148 = no iodine dripping/ low IDD n = 5; Kuqa = no iodine dripping/ high IDD n = 5; Wushi = iodine dripping/ high IDD n = 5)

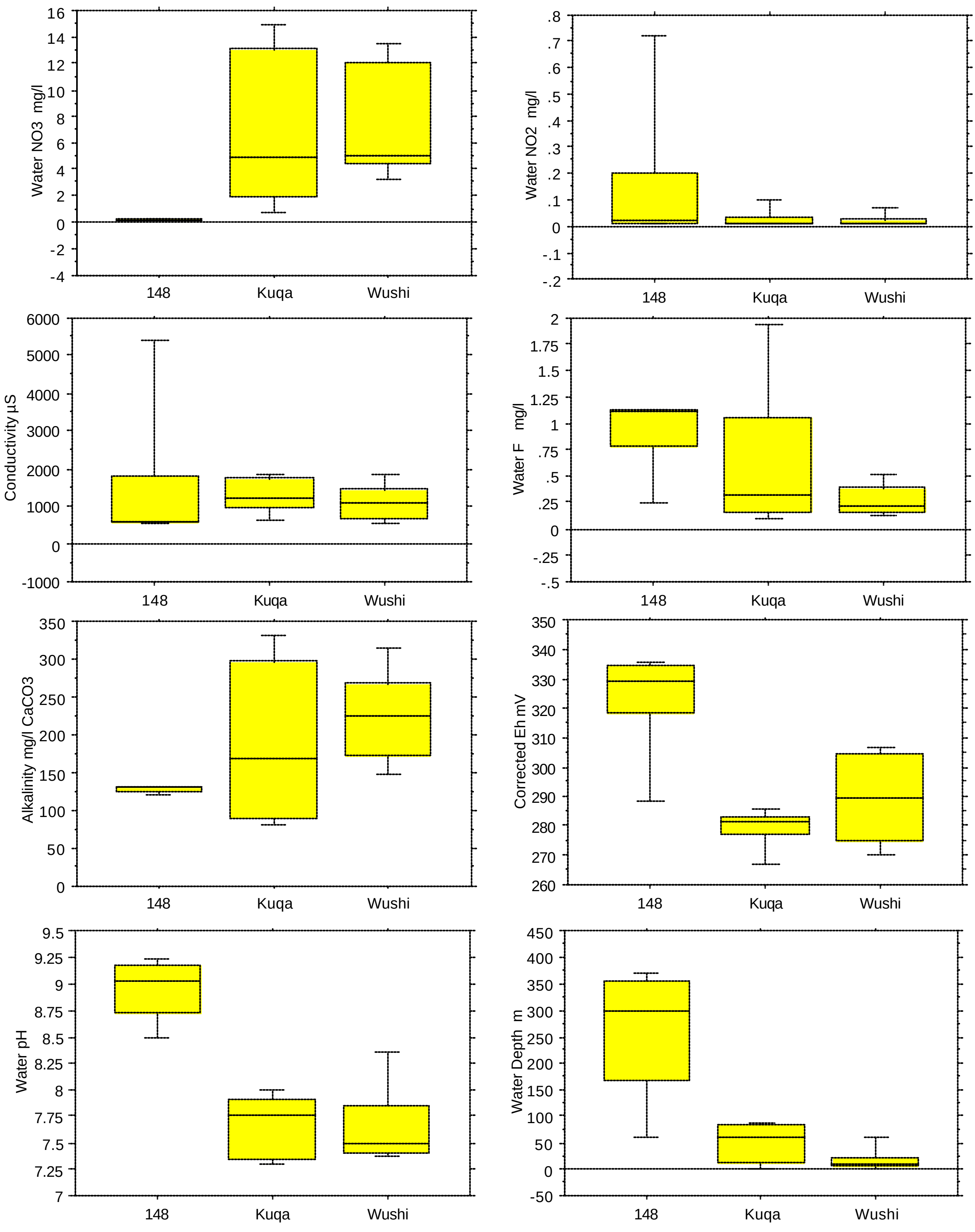
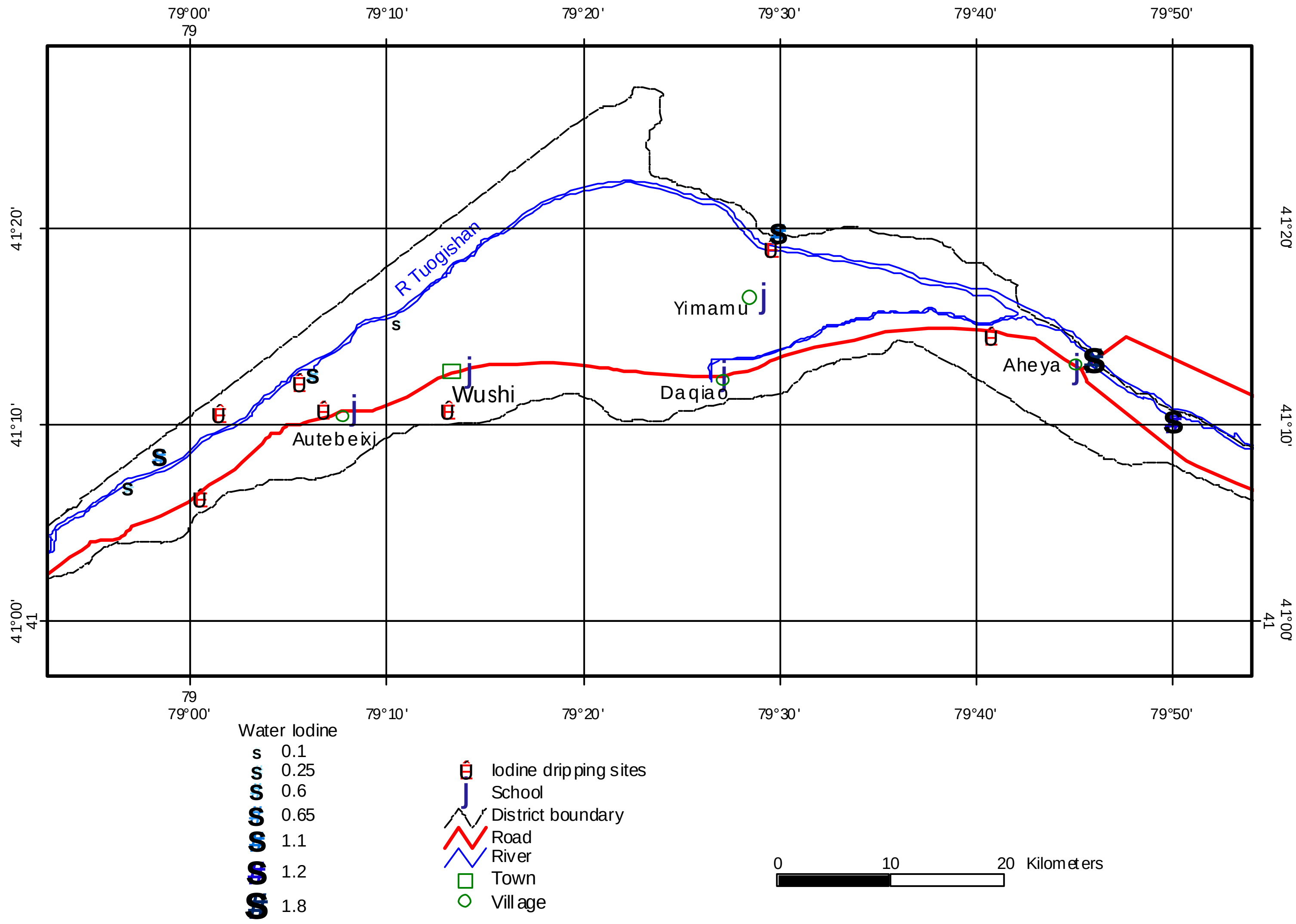


Figure 3.5b Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of water parameter distributions classified by study area.

(148 = no iodine dripping/ low IDD n = 5; Kuqa = no iodine dripping/ high IDD n = 5; Wushi = iodine dripping/ high IDD n = 5)

Figure 3.6 Map of iodine concentrations in water samples (µg/l) collected on along the River Tuogishan in Wushi District (Study Area 3).

(River Tuogishan flows from west to east)



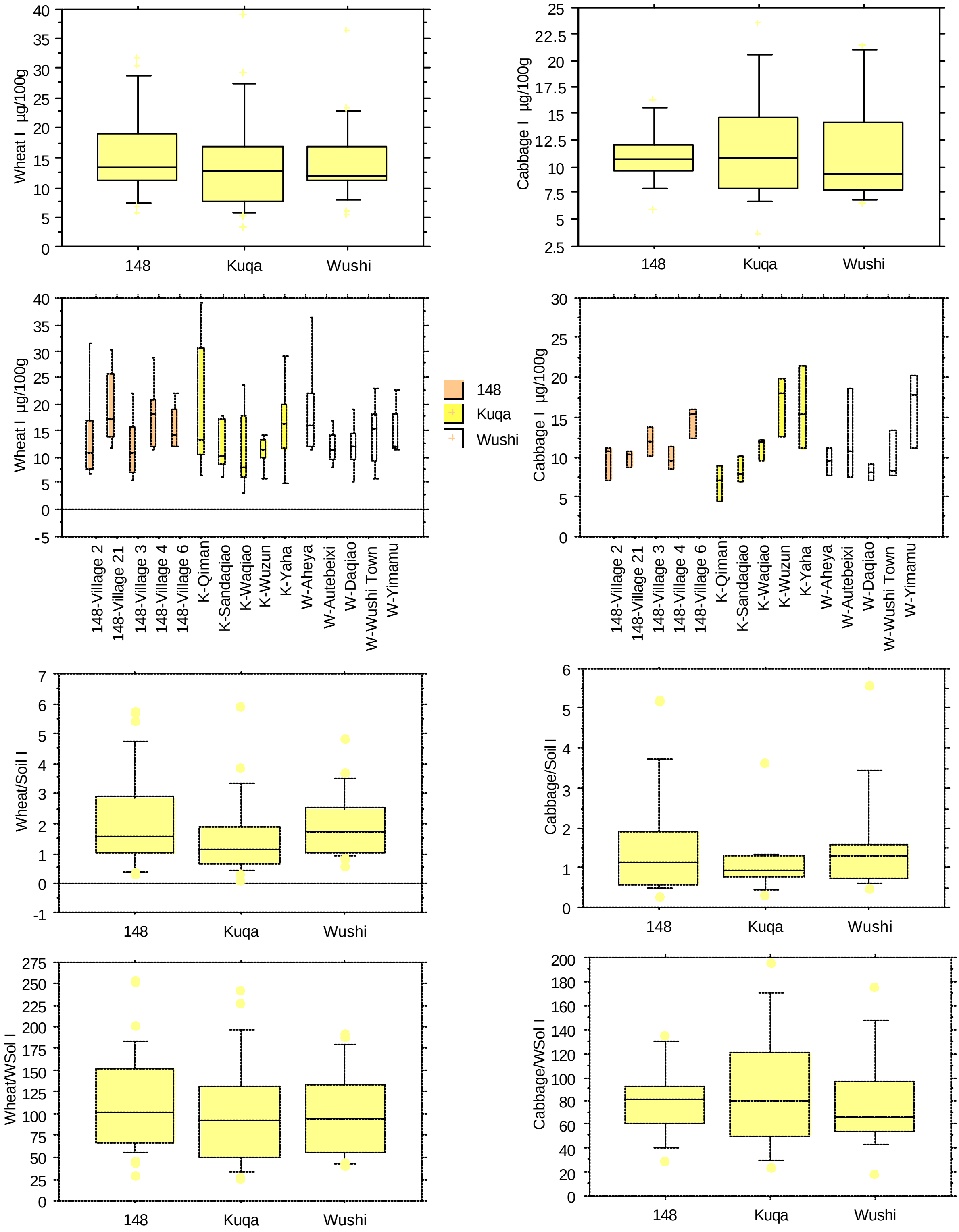


Figure 3.7 Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of iodine contents in wheat and cabbage samples classified by study area and by village and ratios of wheat and cabbage iodine versus soil total and water soluble iodine contents classified by study area.

(148 = no iodine dripping/ low IDD wheat n area = 25, n village = 5, cabbage n area = 14, n village = 3; Kuqa = no iodine dripping/ high IDD wheat n area = 24, n village = 5, cabbage n area = 14, n village = 3; Wushi = iodine dripping/ high IDD wheat n area = 25, n village = 5, cabbage n area = 15, n village =3

3.4.4 Rock and Salt Samples

Two samples of local rock salt collected from a mine north of Kuqa contain trace amounts of total and water-soluble iodine confirming the low iodine status of this salt. It is unlikely that this salt contributes iodine to the local diet. A sample of local coal was collected in Kuqa to assess exposure to iodine via inhalation of coal smoke used as household fuel. The coal also contains trace amounts of iodine and is unlikely to significantly impact upon the iodine loading of the local population (Table 3.12).

TABLE 3.12 IODINE CONTENTS OF TWO ROCK SALT AND A COAL SAMPLE FROM KUQA

Sample	Total I µg/g	Water Soluble I µg/g
UR Rock Salt 'White'	0.30	0.012
UR Rock Salt 'Grey'	0.30	0.012
UR Coal	0.30	0.020

4 Medical Surveys

4.1 SAMPLING METHODS

4.1.1 Sampling Strategy

Although goitre rates in women are usually higher than in children, it was decided for logistic reasons that the medical sampling would be carried out on children rather than women of childbearing age, since children were more easily accessible in schools whilst the women were busy in the fields with the harvest.

Schools were chosen by the local collaborators to cover the geographical area in which the geochemical sampling was being undertaken (see Section 2). Within the schools, classes were chosen randomly until a maximum of 60 children was reached in Wushi and Kuqa Districts and 119 in the boarding school in AC148.

Sample sizes depend on the prevalence of goitre. At a prevalence rate of 5% (95% confidence level (CL) 0-10%) a sample size of 73 is needed. At 10% (95% CL 5-15%) the size is 129, while at 20% (95% CL 15-25%) the size is 246. Since the goitre prevalence rates and full extent of the iodination programmes in the study areas were uncertain, a sample size of 300 children was selected for thyroid volume determinations in each of Wushi and Kuqa Districts, giving 60 children in each of the five villages in each area. The prevalence of goitre in AC148 was expected to be low and so a smaller sample was taken from the five villages for thyroid volume (119 in total). Since the villages around AC148 pool their resources, examining children who attend a central boarding school gave a representative sample for the commune as a whole. All children sampled had date of birth, sex, height, weight and thyroid ultrasound indices recorded as well as the palmer aspect of the right hand photocopied to enable the ratio of the second to fourth fingers to be calculated. This value is seen as a measure of oestrogen/androgen ratios *in utero* and is partly hereditary and partly environmentally (diet) controlled.

A sub-sample of children (50 per area; 10 from each village) was randomly chosen from the main sample to give blood-spot and urine for analysis.

It was recognised that as well as a potential difference in iodine intake between AC148 and Kuqa and Wushi Districts, there was an ethnic difference. All the children in 148 were ethnic Chinese (Han) while the children in Wushi and Kuqa were Uiger (Turki minority).

Although not common practice in medical science, a random numbering system for sample collection was adopted to be compatible with the geochemical survey.

4.1.2 Thyroid Ultrasound

A portable (reconditioned) ultrasound, Aloka SSD-500 with a 50 Hz probe and jelly was used to determine the thyroid volume of the children. It was run from the 220v mains electricity supply of the school with a trip switch and cut out always and sometimes a voltage regulator as well. The ultrasound machine was transported in a thick sealed cardboard box to protect it from the dusty environment and rough roads.

All children were laid supine on a bench or school desk at about elbow height of the seated examiner and the height and breadth of the right and left lobes of the thyroid were measured and recorded on the student's individual survey record (Plate 4.1).

The probe was then turned laterally and the depth of the two lobes recorded. Owing to scribal problems in 148, the left and right height and the right and left breadth were occasionally transposed on the sheet. This does not affect the calculation of thyroid volume but means that individual lobe sizes cannot be compared between 148 and Wushi and Kuqa Districts.

4.1.3 Height and Weight

All children had their height (to the nearest centimetre) measured on a stadiometer provided by the local Disease Prevention Station of the Health Department and then recorded on the student's survey form. Each of the three areas provided their own stadiometer (Plate 4.2). However, in each area the height of the medical researcher remained constant so the readings can be taken to be equivalent. One recorder measured height in Wushi and Kuqa Districts while in AC148 another person recorded the heights and weights. The height measurements made in Kuqa and Wushi Districts had one centimetre deducted from the reading to compensate for shoes at the time of reporting. Retrospectively, one centimetre has been deducted from the height results for AC148 presented in this report to make the data compatible with the other areas.

Weight (to the nearest kilogram) was measured by the same recorder as height: in AC148 a balance scale was used while in Wushi and Kuqa dial scales were used. However, in each area the weight of the medical researcher remained constant so the readings can be taken to be equivalent. No deductions were made for the light clothing (shirt, trousers, shoes and thin jersey) the children wore.

At the same time, date of birth and sex were recorded on the student survey form. Name was also recorded but not used subsequently in the analysis. However, in the event of confusion over a form or a sample the use of the child's name enabled problems to be solved quickly.

4.1.4 Blood-spot Tests and Urine

Blood-spots were taken from the children by finger-prick onto a blotting paper form as used in the UK for testing newborns for thyroid dysfunction. Four circles were fully filled with venous blood fully permeating to the back of the card. Relevant details (survey serial number, name, sex, ethnicity, date of birth) were recorded on the form. The form was then placed in a prepared, waxed envelope for storage at room temperature.

Urine was taken in 30 ml containers and stored at room temperature until transported to the laboratory. Survey serial number was recorded on the bottle.

All specimens were recorded on the student survey forms.

4.1.5 Hand Photocopy

Each child had the right hand photocopied on a portable photocopier to enable second and fourth digit length to be measured (Plate 4.3). The table of the photocopier moved over the lamp. This gave many children initial difficulty but all were eventually copied. The electrical supply in Qiman was insufficient to run the photocopier and no hand results were obtained in this village.

4.2 ANALYTICAL METHODS

4.2.1 Methods for Classroom Examinations

Thyroid volume was calculated by the formula:

First lobe V_1 = height x breadth x depth x 0.479

Second lobe V_2 = height x breadth x depth x 0.479

Total volume of thyroid $V_3 = V_1 + V_2$.

The volume of the isthmus is considered negligible.

Student's t-test was used to compare the mean thyroid volumes. Thyroid volume was compared with Chinese and European standards for age and surface area.

Thyroid volume is influenced by a number of factors, of which the most important are age, size, iodine intake and thyroid hormone status. Exploration of these factors was carried out by regression analysis.

Size is influenced both by height and weight and body surface weight is a convenient way of amalgamating both these factors. Body surface area of the child was calculated by the formula: $weight_{kg}^{0.425}$ x $height_{cm}^{0.725}$ x 71.84 x 10^{-4}.

All statistical analyses outlined in this Chapter were carried out using the StatsDirect® computer package (Buchan, 2002).

4.2.2 Spot-Test Analyses

The blood-spot-test papers were analysed for T4 (thyroxine) and TSH (Thyroid Stimulating Hormone) at the biochemical laboratory of the Alder Hey Children's Hospital, Liverpool by Perkins Elmer Delfia Wallac fluorescent immunoassay.

4.2.3 Urine Analyses

Urinary iodine is a recognised way of approximating dietary intakes of iodine.

Urine samples were submitted to the analytical laboratories of the Endemic Research Institute in Urumqi for preparation and determination of iodine by Barker's modified incineration technique and catalytic reduction of the ceric ion (Ce^{4+}) by arsenite salt (As^{3+}). Urinary fluorine was also determined in Urumqi by Ion Selective Electrode. Limits of detection for iodine and fluorine in urine were 1 µg/l and 0.05 mg/l respectively. Results for standard reference materials show good precision of the methods (Table 4.1). In general, analytical replicate results show good repeatability of the methods (Table 4.2). However, the results for fluorine in urine samples 2260 and 3071 show marked variation (> 20%) and probably indicate errors in number and value reporting rather than problems with the sampling and analytical methods but do show that the fluorine and urine results generated by the present study should be treated with caution.

Analytical replicate results were averaged for each sample prior to statistical analysis of the data.

TABLE 4.1 FLUORINE AND IODINE ANALYTICAL RESULTS FOR URINE STANDARD REFERENCE MATERIALS

Standard Material	F mg/l Reference Range	Analysis mg/l
QCS-0021	1.71 - 2.23	2.06
QCS-0022	4.72 - 6.82	6.45
Standard Material	**I µg/l Reference Range**	**Analysis µg/l**
QC-0003-03-1	198.0 - 210.0	202.31
QC-0003-03-1	198.0 - 210.0	205.06
QC-0003-04-1	198.0 - 210.0	203.49
QC-0003-04-1	198.0 - 210.0	209.25

EDI Laboratories, Urumqi

TABLE 4.2 ANALYTICAL REPLICATE RESULTS FOR FLUORINE AND IODINE IN URINE

Sample No	F mg/l	Sample No	I ug/l
1006	2.15	1046	70
1006	2.15	1046	68
V	*0.00*	*V*	*2.05*
1013	1.65	1115	600
1013	1.55	1115	598
V	*4.42*	*V*	*0.24*
1036	4.40	2034	810
1036	4.40	2034	814
V	*0.00*	*V*	*0.35*
1041	2.10	2068	403
1041	1.90	2068	393
V	*7.07*	*V*	*1.78*
1047	2.55	2070	38
1047	2.60	2070	40
V	*1.37*	*V*	*3.63*
2064	0.96	2263	307
2064	1.05	2263	303
V	*6.33*	*V*	*0.93*
2162	0.44	2267	400
2162	0.42	2267	400
V	*3.29*	*V*	*0.00*
2260	1.15	2280	265
2260	0.66	2280	270
V	*38.29*	*V*	*1.32*
3029	0.48	3011	700
3029	0.48	3011	695
V	*0.00*	*V*	*0.51*
3063	4.90	3054	510
3063	4.70	3054	514
V	*2.95*	*V*	*0.55*
3066	2.60	3069	327
3066	2.85	3069	325
V	*6.49*	*V*	*0.43*
3071	1.30	3099	282
3071	2.00	3099	277
V	*30.00*	*V*	*1.26*
3077	0.66	3123	255
3077	0.59	3123	262
V	*7.92*	*V*	*1.91*
3104	0.75	3213	417
3104	0.62	3213	423
V	*13.42*	*V*	*1.01*
3254	0.64		
3254	0.67		
V	*3.24*		
3278	0.56		
3278	0.59		
V	*3.69*		

V = coefficient of variation expressed as % EDI Laboratories, Urumqi

4.2.4 Photocopy Analyses

The ratio of the second to the fourth digit (2D:4D ratio) was determined by measurement of the photocopy of the right hand from the palmar crease to the fingertip using vernier callipers recording to 0.01 mm. There is no significant difference between 2D:4D ratios measured directly from hands and those from photocopies of hands. This work formed part of a larger study undertaken by Dr John Manning of Liverpool University, to whom we are grateful for his willingness to contribute his findings to the present study.

4.3 RESULTS

All medical analyses are listed as tables in Appendix H. In this section the data are summated in terms of the three study areas.

4.3.1 Demography

The numbers of children examined are given by village in Tables 4.3 – 4.5 and the age structure of the sample population is given in Table 4.6. The average age of the children was 8.0 years in AC148, 9.9 years in Wushi and 8.5 years in Kuqa.

TABLE 4.3 NUMBERS OF CHILDREN EXAMINED IN AC148

	All Subjects		Blood & Urine	
	f	m	f	m
Grand Total	60	59	25	27

f = female m = male

TABLE 4.4 NUMBERS OF CHILDREN EXAMINED IN KUQA

Village	All Subjects		Blood & Urine	
	f	m	f	m
Qiman	30	30	5	5
Sandaqiao	30	30	5	5
Waqiao	31	31	6	6
Wuzun	29	28	3	4
Yaha	30	31	6	5
Grand Total	150	150	25	25

f = female m = male

TABLE 4.5 NUMBERS OF CHILDREN EXAMINED IN WUSHI

Village	All Subjects		Blood & Urine	
	f	m	f	m
Aheya	28	32	5	5
Daqiao	28	32	4	6
Autebeixi	40	20	5	5
Wushi Town	28	32	5	5
Yimamu	37	23	5	5
Grand Total	157	140	24	25

f = female m = male

TABLE 4.6 AGE STRUCTURE OF THE SAMPLE POPULATION IN EACH STUDY AREA

Years	AC148	Kuqa	Wushi
Age < 6	0	0	1
Age 6	21	15	0
Age 7	43	68	7
Age 8	36	135	72
Age 9	14	53	93
Age 10	1	15	63
Age 11	4	12	35
Age 12	0	1	14
Age 13	0	0	11
Age 14	0	0	1
No age	0	1	0

The body surface areas of the children are shown in Table 4.7 and mean values for each area can be summarised as follows: AC148 0.93 m^2 (n = 119; 95% CL 0.93 to 0.95), Wushi 0.97 m^2 (n = 297; 95% CL 0.96 to 0.98), Kuqa 0.92 m^2 (n = 297; 95% CL 0.91 to 0.93). The Wushi children were older, accounting for their greater surface area, although the children as a whole are smaller than their European counterparts.

TABLE 4.7 BODY SURFACE AREA OF THE CHILDREN IN EACH STUDY AREA

Body Surface Area m^2	AC 148	Kuqa	Wushi
<0.8		2	1
0.8-0.9	20	58	22
0.9-1.0	58	142	113
1.0-1.1	25	80	107
1.1-1.2	12	13	36
1.2-1.3	2	0	14
1.3-1.4	2	2	4
No data	0	3	0

The growth of children in the three areas is different. The slope of the graph of surface area (a product of height and weight) against age is steepest for AC148 and flattest for Wushi (Figure 4.2 Section 4.3.2) consistent with either the historical goitre prevalence or the social gradient from Wushi as the poorest and most remote of the three areas and AC148 as the most developed with closer access to larger towns or both.

4.3.2 Thyroid Volume

The range of thyroid volumes differ between the three study areas (Figure 4.1 and Tables 4.8 - 4.11), with AC148 having the lowest average volume (0.53 mls, 95% CL 0.48 to 0.58) and Wushi the highest (1.03 mls, 95% CL 0.96 to 1.10). Kuqa was intermediate (0.88 mls, 95% CL 0.84 to 0.92). Although all three areas have volumes within the normal range, the differences between the means are all significant ($p<0.001$) by unpaired t-tests assuming unequal variances (Table 4.12).

Figure 4.1 Bar chart of average child thyroid volumes (+/- 95% confidence intervals) for each study area

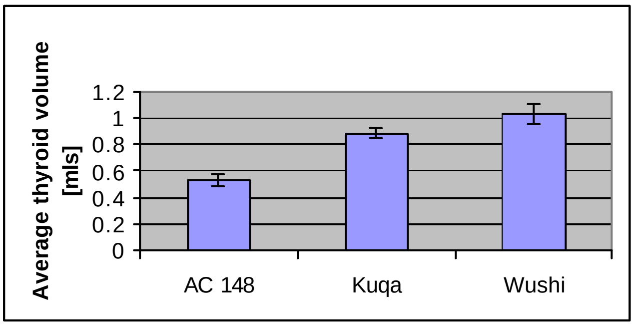


TABLE 4.8 CHILD THYROID VOLUME RANGES FOR EACH STUDY AREA

Thyroid Volume mls	AC148	Kuqa	Wushi
Minimum	0.10	0.19	0.22
Maximum	1.83	2.20	7.09

The normal values for thyroid volumes differ by age (Tables 4.9 – 4.11, Appendix H) but all volumes in this study were below the lower limits of normal. One boy in Wushi (Daqiao village) had a markedly larger thyroid than the others (7.09 mls) but for his age (13.5 years) was below the Chinese lower limit (9 mls), so does not have a goitre. Only 3 children in Wushi, all older boys, had thyroid volumes greater than 2.75 mls (age 13 years, thyroid 3.36 mls, Daqiao; age 9.4 years, thyroid 3.26 mls, Yimamu and the boy mentioned above – age 13.5 years, thyroid 7.09 mls, Daqiao). Otherwise, all children in all three areas had thyroid volumes below the lower limits for European or Chinese children by age and sex and below the lower limit for body surface area (Tables 4.13 and 4.14).

TABLE 4.9 AVERAGE CHILD THYROID VOLUME (MLS) IN AGRICULTURAL COMMUNE 148

	f	m
Average	0.51	0.55

f = female m = male

TABLE 4.10 AVERAGE CHILD THYROID VOLUME (MLS) IN KUQA

Village	f	m
Qiman	0.88	1.03
Sandaqiao	1.01	1.02
Waqiao	0.74	0.92
Wuzun	0.85	0.97
Yaha	0.67	0.70
Average	0.83	0.92

f = female m = male

TABLE 4.11 AVERAGE CHILD THYROID VOLUME (MLS) IN WUSHI

Village	f	m
Aheya	0.80	0.88
Daqiao	0.87	1.24
Autebeixi	1.22	1.07
Wushi Town	0.93	0.92
Yimamu	1.06	1.27
Average	1.00	1.06

f = female m = male

TABLE 4.12 UNPAIRED T-TEST OF CHILD THYROID VOLUMES

Areas	SE	df	t(d)	Lower 95% confidence interval	Upper 95% confidence interval
AC148 & Wushi	0.043	398.045	11.608	-0.59	-0.42
AC148 & Kuqa	0.033	262.856	10.409	-0.41	-0.28
Kuqa & Wushi	0.040	483.656	3.868	0.08	0.23

SE = Combined standard error All P values <0.0001
df = Degrees of freedom
t(d) = t-test statistic, assuming unequal variances

TABLE 4.13 NUMBER OF CHILDREN WITH THYROID VOLUME GREATER THAN THE LOWER LIMIT OF VARIOUS STANDARDS IN THE THREE STUDY AREAS

Standard	Lower Limit	AC148	Kuqa	Wushi
Chinese 6 year old boy	>3.5 mls	0	0	1
Body Surface Area <0.8 m^2	>4.7 mls	0	0	1
European 6 year old girl	>5.0 mls	0	0	1

TABLE 4.14 STANDARD THYROID VOLUMES IN EUROPEAN AND CHINESE CHILDREN

	Europe Standard Thyroid Volumes mls		China Standard Thyroid Volumes mls
Age	**Male**	**Female**	**Child**
6 years	5.6	5.0	3.5
7 years	5.7	5.9	4.0
Body Surface Area (m^2)			
0.8	4.7	4.8	
0.9	5.3	5.9	

The spread of thyroid volume values by surface area or by age (Figures 4.3 and 4.4) shows a decreasing trend from Wushi through Kuqa to AC148, in line with the history of iodine deprivation and subsequent supplementation in these areas.

The best predictors of thyroid volume by multiple linear regression analysis were age and surface area (Figures 4.2– 4.4).

Multiple linear regression (all children)

Intercept	b0 = -0.83	t = -1.14	P = 0.2545
Age	b1 = 0.06	t = 3.31	P = 0.001
Surface area	b2 = -0.46	t = -0.09	P = 0.9285
AC148	b3 = -0.34	t = -7.05	P < 0.0001
Wushi	b4 = 0.02	t = 0.41	P = 0.683
Sex	b5 = -0.003	t = -0.09	P = 0.9249
Height	b6 = 0.01	t = 0.32	P = 0.7527
Weight	b7 = 0.02	t = 0.296	P = 0.7671

The full regression equation is:

Thyroid Volume (mls) = -0.83 + (0.05)Age (years) - (0.46) Surface area (m^2) – (0.34)AC148 + (0.02)Wushi - (0.003)Sex + (0.009)Height cm + (0.02)Weight kg

StatsDirect®, the statistics programme used, allows the extraction of the best subset, a subset that accounts for all the variation in thyroid volume found by the full equation. The following was the result:

Thyroid volume (mls) = -0.62 + (0.06)Age (years) + (1.1)Surface Area (m^2) – (0.34)AC148 – (0.001)Sex

In other words, thyroid volume increases by 0.06 ml for every year increase in age, by 1.1 ml for every m^2 increase in surface area and decreases by 0.34 mls if the child is resident in AC148. There was no difference between residency in Wushi or Kuqa in this equation. There is a further slight decrease of 0.001 mls if the child is male and 0.002 mls if female.

Although important variables, age, surface area and residency account for only 22% of the variation in thyroid volume. The rest of the variation in thyroid volume is due to unknown or unmeasured factors.

In order to determine whether iodine intake (measured as the dietary proxy: urinary iodine) or thyroid activity (measured by thyroid hormones) are factors determining thyroid volume the regression analysis was calculated on the data for the subset of children who had blood and urine measurements done.

Multiple linear regression (children with blood & urine tests, only)

Intercept	b0 = -0.89	t = -0.23	P = 0.8161
Age	b1 = 0.04	t = 1.27	P = 0.2051
Surface area	b2 = 0.72	t = 1.58	P = 0.1168
AC148	b3 = -0.34	t = -3.68	P = 0.0003
Wushi	b4 = 0.17	t = 1.94	P = 0.0545
Sex	b5 = -0.11	t = -1.59	P = 0.1139
TSH	b6 = 0.01	t = 0.41	P = 0.6818
T4	b7 = 0.002	t = 0.42	P = 0.6725
Urinary I	b8 = -0.00002	t = -0.17	P = 0.8683

The full regression equation thus becomes:

Thyroid Volume (mls) = -0.089 + (0.04)Age + (0.72)Surface Area (m^2) – (0.17)AC148 + (0.17)Wushi – (0.11)Sex + (0.01)TSH (mIU/l whole blood) + (0.001)T4 (nmol/l whole blood) – (0.00002) Urinary Iodine(µg/l)

Extracting the best subset gives the following result:

Thyroid volume (mls) = 0.03 + (1.06)Surface Area (m^2) – (0.36)AC148 + (0.20)Wushi – (0.11)Sex

In this subset, the addition of the blood and urine factors did not help predict the thyroid volume, although 30% of the variance could be accounted for by surface area and place of residence.

Plate 4.1 Ultrasound thyroid volume determinations in Kuqa, study area 2

Plate 4.2 Height and weight measurements in Wushi, study area 3

Plate 4.3 Hand photocopy measurements in Wushi, study area 3

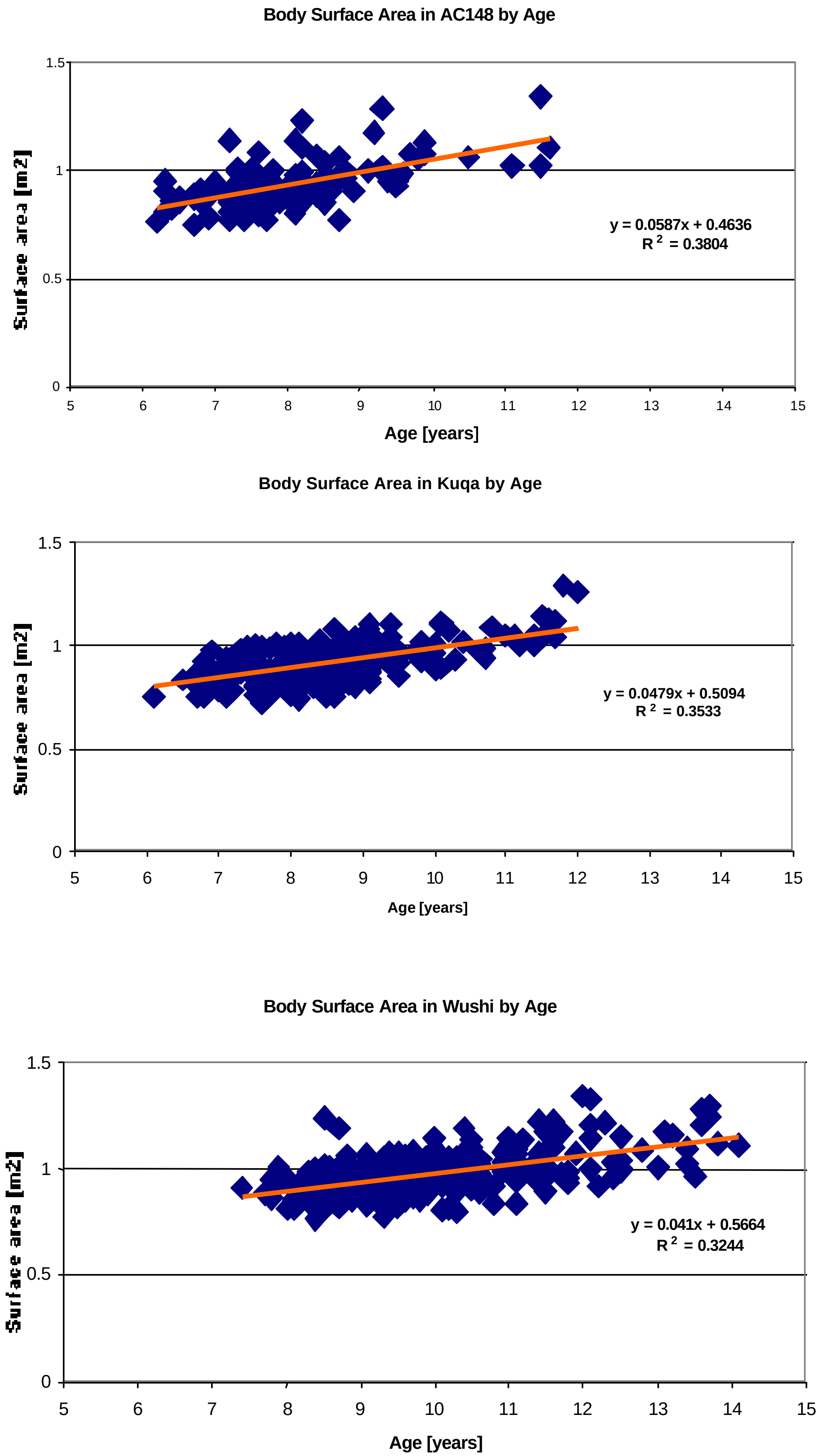


Figure 4.2 Regression plots of child body surface area by age for the three study areas.

(148 = no iodine dripping/low IDD; Kuqa = no iodine dripping/high IDD and Wushi = iodine dripping/high IDD)

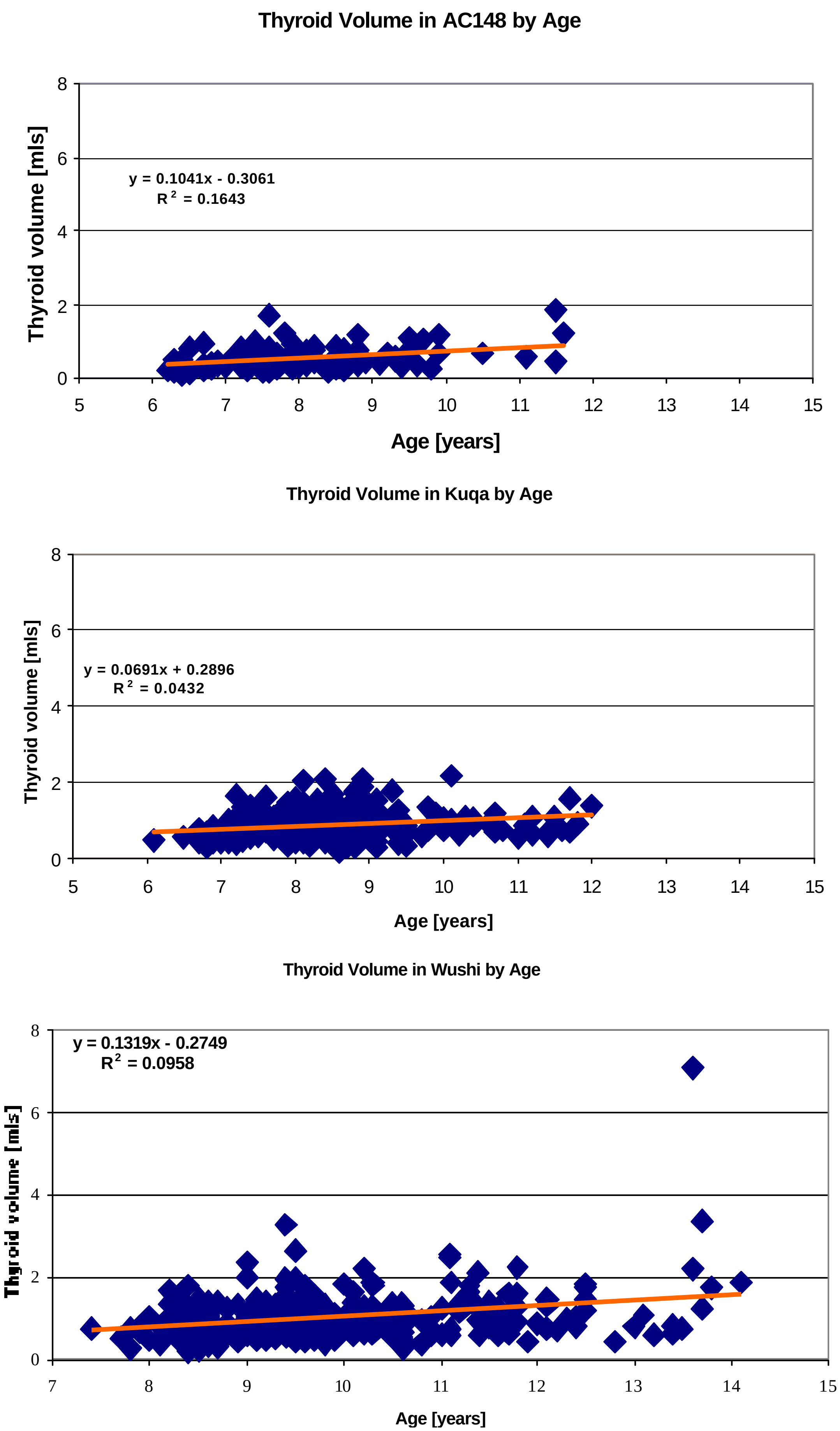
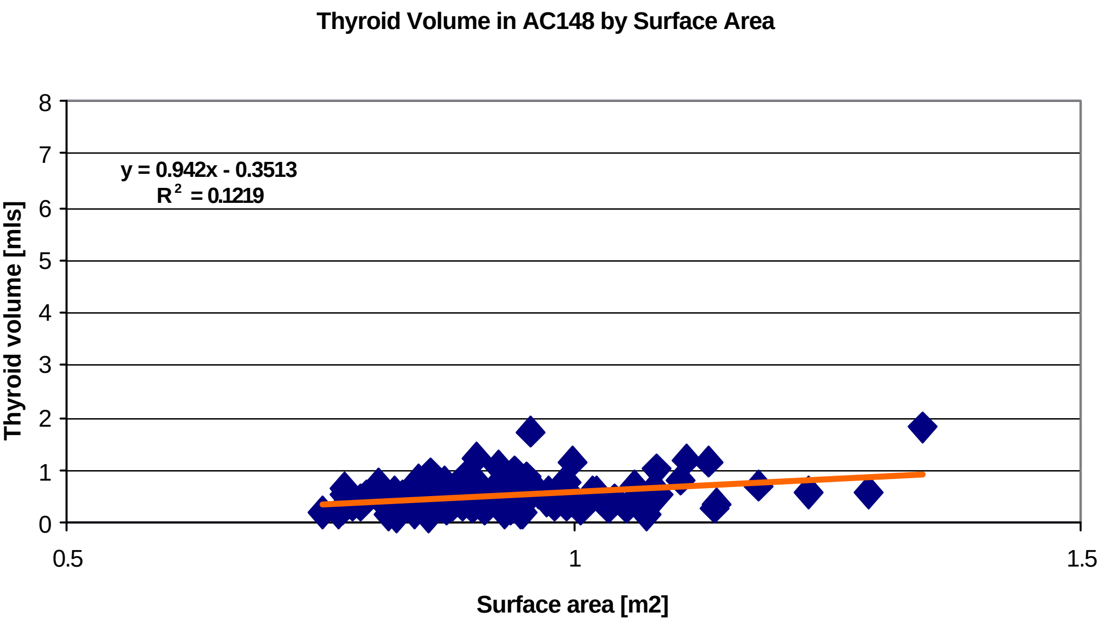
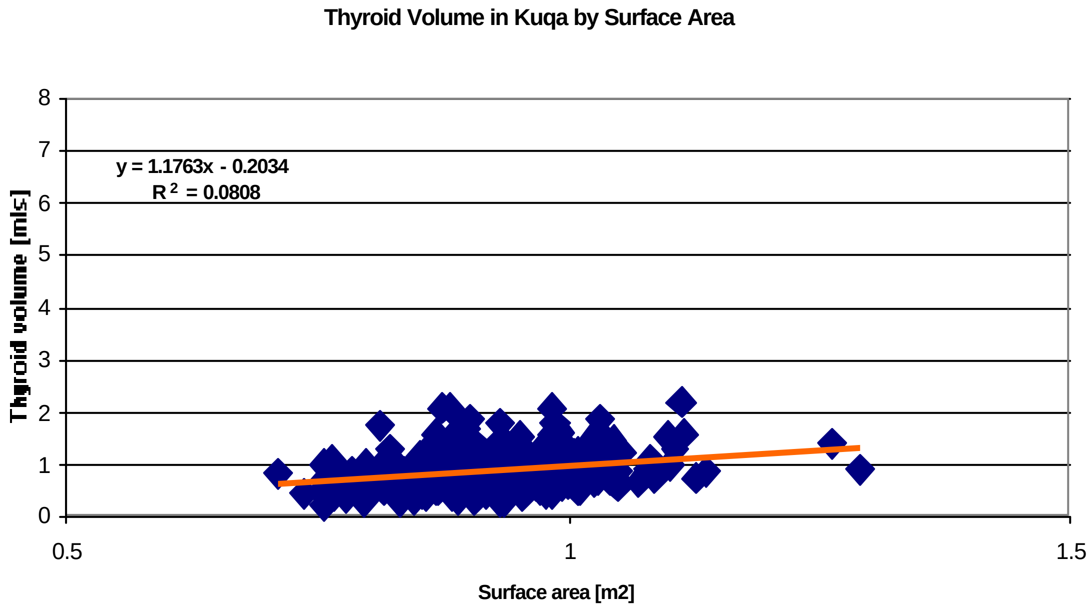


Figure 4.3 Regression plots of child thyroid volumes by age for the three study areas.

(148 = no iodine dripping/low IDD; Kuqa = no iodine dripping/high IDD and Wushi = iodine dripping/high IDD)





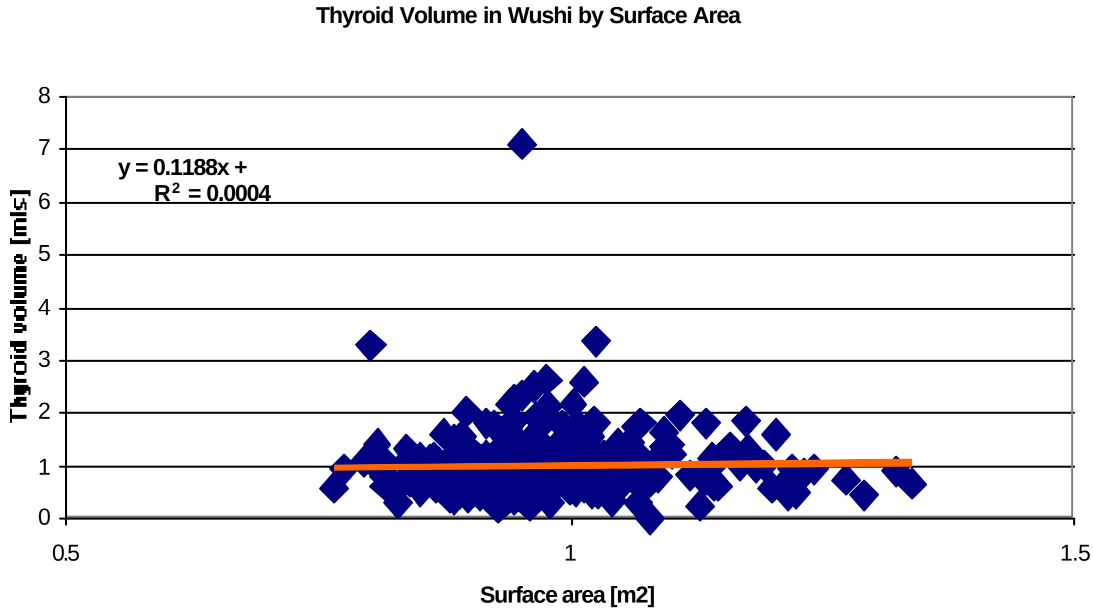


Figure 4.4 Regression plots of child thyroid volumes by body surface area for the three study areas.

(148 = no iodine dripping/low IDD; Kuqa = no iodine dripping/high IDD and Wushi = iodine dripping/high IDD)

4.3.3 Spot-Test Results Hormones (TSH, T4)

The mean hormone levels are given by village in Table 4.15 for thyroxine (T4) (total) and Table 4.16 for thyroid stimulating hormone (TSH). The hormone values do not add any precision to the estimate of thyroid volume by height, weight, age or place of residence, as shown in the regression equation above.

TABLE 4.15 MEAN LEVELS OF CHILD TOTAL THYROXINE (T4) IN EACH OF THE STUDY VILLAGES

Village	N	Mean	LCI	UCI
AC148	51	45.36	42.24	48.47
Kuqa (All)	50	41.01	38.14	43.89
Qiman	10	39.54	34.93	44.15
Sandaqiao	10	47.27	37.58	56.96
Waqiao	10	37.93	31.10	44.76
Wuzun	10	41.23	34.34	48.12
Yaha	10	39.10	32.37	45.83
Wushi (All)	50	44.20	40.83	47.57
Aheya	10	36.14	30.55	41.73
Autebeixi	10	47.60	40.05	55.15
Daqiao	10	39.08	33.41	44.75
Wushi	10	53.12	46.38	59.86
Yimamu	10	45.05	34.01	56.09

Total T4 measured as nmol/L whole blood
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval
N = number

TABLE 4.16 MEAN LEVELS OF CHILD THYROID STIMULATING HORMONE (TSH) IN EACH OF THE STUDY VILLAGES

Village	N	Mean	LCI	UCI
AC148	52	1.79	1.52	2.06
Kuqa (All)	50	1.31	1.01	1.61
Qiman	10	0.90	0.49	1.31
Sandaqiao	10	1.00	0.33	1.67
Waqiao	10	1.40	0.39	2.41
Wuzun	10	1.77	0.99	2.55
Yaha	10	1.49	0.75	2.23
Wushi (All)	50	1.17	0.89	1.45
Autebeixi	10	0.79	0.46	1.12
Aheya	10	1.43	0.87	1.99
Daqiao	10	1.24	0.38	2.10
Wushi	10	1.63	0.76	2.50
Yimamu	10	0.76	0.10	1.42

TSH measured as mIU/l whole blood
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval
N = number

Unlike the range in thyroid volume, which matches the historical prevalence of goitre, the distribution of thyroid hormones is highest in AC 148 but lowest in Kuqa (Tables 4.15 and 4.16).

The median values for the three areas (AC 148: T4 47.5 nmol/l whole blood, TSH 1.75 mIU/l whole blood; Kuqa: 40.90, 1.10; Wushi: 43.25, 0.85) are similar to the mean values for T4 but differ most for TSH in Wushi.

The WHO reports higher prevalence rates of mortality and cretinism in mothers whose serum total T4 is below 25 µg/ml (= 0.25 µg/dl x 12.87 = 3.22 nmol/l) (WHO, 1996). Based on village mean values, none of the whole blood total T4 levels in children in the study area are below this level.

4.3.4 Urinary Iodine & Fluorine

The data on urinary iodine and urinary fluorine are presented in Appendix H and summarised in Table 4.17.

TABLE 4.17 SUMMARY OF URINARY IODINE AND FLUORINE CONCENTRATIONS IN EACH OF THE STUDY AREAS

Area	Fluorine mg/l				Iodine µg/l			
	N	Min	Max	Mean	N	Min	Max	Mean
All	151	0.03	5.20	1.32	150	5	1112	344
AC148	51	0.03	5.20	1.79	50	50	1112	464
Kuqa (All)	50	0.13	5.00	1.23	50	5	912	245
Qiman	10	0.63	5.00	3.15	10	70	810	425
Sandaqiao	10	0.27	3.30	1.14	10	35	912	296
Waqiao	12	0.28	2.85	0.84	12	15	680	248
Wuzun	7	0.13	0.58	0.33	7	5	85	40
Yaha	11	0.19	0.87	0.57	11	20	345	163
Wushi (All)	50	0.11	4.80	0.94	50	17	1032	324
Aheya	10	0.36	4.80	1.36	10	100	1032	408
Autebeixi	10	0.19	4.60	0.87	10	17	730	329
Daqiao	10	0.12	3.10	0.90	10	20	812	291
Wushi	10	0.21	1.95	0.93	10	25	810	344
Yimamu	10	0.11	1.10	0.62	10	110	400	250

The distribution of urinary iodine is lower in Wushi and Kuqa (Wushi mean 324.5 µg/l, 95% CL 264.0 to 385.0, median 334.5; Kuqa mean 245.2, 95% CL 179.4 to 311.1, median 182.5) than in AC 148 (mean 463.9, 95% CL 395.2 to 532.5, median 460). This is confirmed statistically by the Kruskal-Wallis test T=22.669, $P<0.0001$, showing that at least one sample population tends to yield larger observations than at least one other.

Further refining this by the all-pairwise comparisons of Dwass-Steel-Chritchlow-Fligner reveals that Wushi and Kuqa values are not dissimilar (P=0.0569) while both differ significantly from AC 148 (0.0069 and <0.0001 respectively).

Dietary iodine intake in humans is commonly estimated on the basis of urinary iodine levels according to the thresholds shown in Table 4.18. The cumulative frequency distribution of urinary iodine from the present study (Table 4.19) indicates that in the two old goitrous communities (Wushi and Kuqa) there are still a number of individuals who have a lower than advisable daily iodine intake, as indicated by a urinary iodine level of =100 µg/l per day. Even in the small population sampled for this study, there are too many in both Wushi and Kuqa with a very low intake of iodine (4% and 10% < 20 µg/l, respectively). It is interesting to note that there are fewer people in the historically more isolated and more goitrous Wushi communities with low urinary iodine than in Kuqa, which might be expected to have a better intake.

Interestingly, in Kuqa and Wushi respectively, 34 and 56% of the community may have an excessive, potentially toxic, daily intake, indicated by urinary levels of >300 µg/l per day. While AC148 has only 6% with urinary iodine levels indicating a lower than recommended daily intake it has over 70% in the potentially toxic group.

TABLE 4.18 IODINE NUTRITION RELATED TO URINARY IODINE CONCENTRATION

Median Urinary Iodine Concentration (µg/l)	Corresponding Approximate Iodine Intake (µg/day)	Iodine Nutrition
<20	<30	Severe deficiency
20-49	30-74	Moderate deficiency
50-99	75-149	Mild deficiency
100-199	150-299	Optimal
200-299	300-449	More than adequate
>299	>449	Possible excess

Source: WHO/ICCIDD/UNICEF http://www.people.virginia.edu/%7Ejtd/iccidd/aboutidd.htm

TABLE 4.19 CUMULATIVE FREQUENCY OF URINARY IODINE IN THE THREE STUDY AREAS

Area	Number (%) in each urinary iodine category						N
	=20 µg/l	=50 µg/l	=100 µg/l	>100 µg/l	>200 µg/l	>300 µg/l	
Wushi	2 (4)	6 (12)	7 (14)	43 (86)	36 (72)	28 (56)	50
Kuqa	5 (10)	9 (18)	22 (44)	28 (56)	24 (48)	17 (34)	50
AC 148	0	1 (2)	3 (6)	47 (94)	44 (88)	38 (76)	50

The distribution of urinary fluorine is similar to the distribution of iodine (Wushi mean 0.94 mg/l, 95% CL 0.66 to 1.21; Kuqa mean 1.23, 95% CL 0.87 to 1.60; AC 148 mean 1.79, 95% CL 1.46 to 2.13).

Statistically significant differences are found by the Kruskal-Wallis test T=19.4746, p<0.0001, showing that at least one sample population tends to yield larger observations than at least one other. Further refining this by the all-pairwise comparisons of Dwass-Steel-Chritchlow-Fligner reveals that Wushi and Kuqa are not dissimilar (p=0.6029) while both differ significantly from AC 148 (<0.0001 and 0.0061 respectively).

The variations in urinary fluorine and iodine results in the three study areas are shown graphically in Figures 4.5 and 4.6.

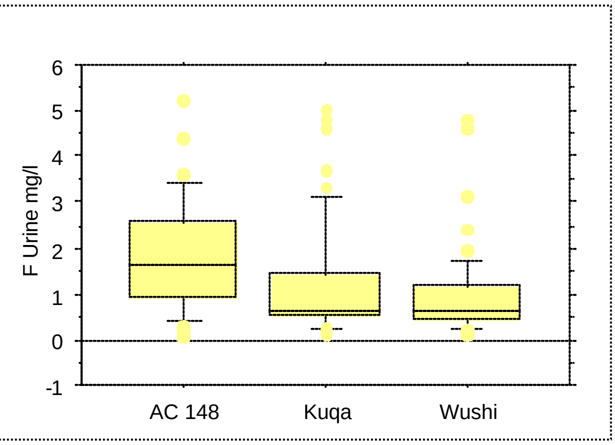


Figure 4.5. Box and whisker plot of the 10th, 25th, 50th, 75th, and 90th percentiles of fluorine distribution in urine samples from the three study areas

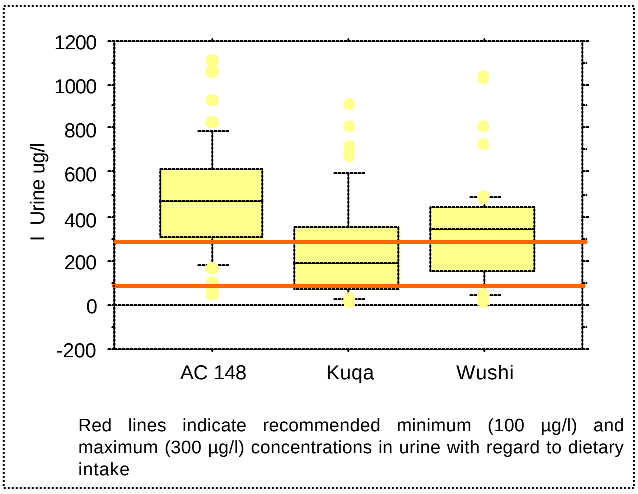


Figure 4.6. Box and whisker plot of the 10th, 25th, 50th, 75th, and 90th percentiles of iodine distribution in urine samples from the three study areas.

4.3.5 Hand Photocopies (courtesy of Dr J Manning)

From the present study, 420 Uiger children (200 boys and 220 girls, mean age 8.96±0.07SE years) from Wushi and Kuqa Districts had their hands photocopied while 118 Chinese children (59 boys and 59 girls, mean age 7.52±0.10SE years) had photocopies made of their hands in AC148. These results were incorporated into a large study of *in utero* hormone levels in children as follows.

Overall, the study also included 151 black Jamaican children (78 boys and 73 girls, mean age 7.66±0.12SE years) and 320 Caucasian children from the northwest of England (160 boys and 160 girls, mean age 8.50±0.13SE years).

The overall mean male ratio of the length of the second and fourth digit (2D: 4D) was lower than mean female 2D: 4D (males 0.955±0.002, females 0.964±0.002, t=3.17, p=0.002).

There were also significant differences in mean 2D: 4D between ethnic groups (English 0.991±0.003, AC 148 0.954±0.003, Wushi and Kuqa combined 0.945±0.002, Jamaican 0.935±0.0003, ANOVA F=103.83, p=0.0001). A two factor ANOVA showed significant independent sex (MS=0.02, F=13.32, p=0.0003) and ethnic differences (MS=0.17, F=105.16, p=0.0001). The variance in 2D: 4D ratio due to ethnic differences was therefore about eight times greater than that due to sex.

The magnitude of the sex difference appeared to be similar within ethnic groups (ANOVA interaction MS=0.0004, F=0.27, p=0.85). There was no relationship between age and 2D: 4D after controlling for sex and ethnicity (age multiple regression coefficient b=0.001, t=1.16, p=0.25.

Participants with masculinised ratios have lower TSH levels compared to participants with feminised ratios; this association is independent of sex, age and ethnicity. There was no relationship between the 2D: 4D ratio and T4 levels.

5 Discussion

5.1 ENVIRONMENTAL IODINE

Although iodine is a ubiquitous element in nature, the oceans are by far the primary reservoir. Volatilisation of iodine from seawater possibly as elemental iodine or as organically-bound iodine (methyl-iodide CH_3I) is the main source of the element in the environment (Fuge, 1996). It is estimated that every year 400 000 tons of iodine escape from the surface of the oceans (Hetzel and Maberly, 1986). The geochemical cycle of iodine involving easy transfer to the atmosphere and mechanical removal from soils is critically important in determining its distribution in the environment. Due to its large ionic radius, iodine is seldom found in primary minerals therefore concentrations in many rocks are uniformly low. However, concentrations in sedimentary rocks can be more variable. Marine sediments generally contain more iodine than non-marine sediments and shales tend to have higher concentrations than sandstones. Some limestones are relatively enriched in iodine, however, greatest enhancement occurs in organic-rich sediments (> 40 µg/g) (Fuge, 1996). The iodine content of soils is generally controlled by the quantity of the element in the environment and the ability of the soil to fix iodine - the Iodine Fixation Potential (Fuge and Johnson, 1986). The major source of iodine in most soils is wet and dry deposition from the atmosphere as the iodine content of rocks generally contributes little during weathering to soils. Indeed soil iodine levels tend to be greater than that of the parent materials. In general, coastal soils contain more iodine than continental soils and in regions where there is high rainfall, iodine tends to be enriched in soils as it is flushed out of the atmosphere on a regular basis (Fuge, 1996).

Several factors control the retention of iodine in soils. Organic-rich soils have been show to contain higher levels of iodine than other soils. Johnson (1980) demonstrated that iodine was associated with organic matter in topsoil samples (0 - 20 cm), which plays an important role in fixing iodine in the upper layers of soil exposed to the atmosphere. Whitehead (1984) demonstrated that soil iron (Fe) and aluminium (Al) oxyhydroxides also play an important role in the sorption of iodine. Clay minerals also retain iodine in soils but this fixation mechanism is thought to be less important than organic matter and Fe and Al oxyhydroxides. Iodine sorption onto Fe and Al oxyhydroxides and clay minerals is greatest in acid conditions and little sorption takes place under neutral and alkaline conditions.

However, neutral to alkaline soils developed over limestones are often much richer in iodine than acid soils from adjacent areas. Fuge (1996) accounts for this phenomenon in terms of the recycling of iodine in the soil environment. Although the volatilisation of iodine from the marine environment and subsequent transfer on land represents the most important stage of the iodine geochemical cycle, the zone of iodine enrichment in soils close to the coast is relatively narrow (for example, approximately 20 km in the UK). It is therefore unlikely that much of the marine derived iodine directly reaches central continental areas. The gaseous iodine found in continental atmospheres is probably derived from the revolatilisation of iodine from soils in a step-wise progression from the marine environment across the continental interior.

Fuge (1996) proposes the following controls on iodine in soils. Iodine added to soils from precipitation can be in the forms I^- or IO_3^-. A proportion of these ions will be adsorbed in the soil by organic matter, Fe and Al oxyhydroxides and clay minerals. The amount of sorption will be controlled by a number of factors including the abundance of these soil components and the soil pH. However, some of the iodine will remain in a mobile form and the fate of this iodine will be determined by the Eh-pH regime of the soil. In acid oxidising soils the IO_3^- will be converted to volatile forms and lost to the atmosphere whereas in neutral and alkaline soils I^- will be converted to IO_3^- and retained in the soil. Organic rich and alkaline soils therefore pose a barrier to the migration of iodine in the terrestrial environment.

Interestingly, several historic endemic areas of IDD are associated with adequate levels of iodine in soil (Fuge, 1996). This may be because plants do not necessarily uptake significant quantities of iodine from soils into the food chain (Al-Ajely, 1985). Absorption of iodine from the atmosphere by plant leaves may be a more important mechanism for plant uptake hence the availability of volatile iodine from the soil rather than the soil total iodine contents is a major factor in assessing iodine deficient environments (Whitehead, 1984). However, iodine rich fertilisers applied to soils have been shown to double or triple the levels of iodine in food crops and pastures (Hetzel and Maberly, 1986).

Bearing these factors in mind, it is hardly surprising that the results of the geochemical investigations carried out during the present study indicate that that total and water-soluble iodine concentrations in the soils of the three study areas are very low (0.030 – 3.900 µg/g and 0.012 – 0.040 µg/g respectively) and are lower than values reported in other IDD endemic areas such as Sri Lanka (Table 5.1). The three study areas lie within an arid climate with very low rainfall therefore minimal atmospheric depositional inputs of iodine. In addition, the study areas are located in a continental interior, far from the sea, on the landward side of a highly alkaline desert environment. Any volatilised marine iodine circulating in weather systems drawn in over the continent is likely to be trapped in the arid desert to the south before reaching the study areas. Furthermore, the soils in the study areas are very sandy and contain very low organic matter contents limiting the ability of the soil to trap and retain iodine and the amount of water soluble or mobile iodine in the soil is very low compared to other areas (Table 5.1). Despite the low soil contents, wheat iodine levels (32 – 389 ng/g) are similar to results reported from elsewhere in the world (Table 5.1). In contrast, cabbage iodine concentrations (36 – 235 ng/g) are marginally lower than in other areas of the world (Table 5.1). The differences between wheat and cabbage iodine status are probably due to the different plant types. Wheat concentrations in Xinjiang are similar to other areas of the world because the grain-head of the plant is generally a poor source of iodine regardless of soil iodine contents. Muramatsu et al. (1985) have shown that the soil-to-plant transfer factor for iodine in cereal plants is very low and that, for example, 1000 times more iodine is taken up in the leaves of rice plants than in the grain. Cabbage being a leafy vegetable is a far more sensitive indicator of environmental iodine levels.

Although the iodine concentrations in crops reported in the present study are broadly similar for the three study areas, the soil geochemical evidence suggests that the presence of limestone and higher concentrations of Ca and Mg and resultant higher pH of the soils in the Wushi and Kuqa areas will inhibit the volatilisation of iodine from the soil into the crops compared to the AC148 area. This may in part explain the historically greater prevalence of IDD in these two areas.

Wheat iodine values range widely from low levels comparable to pre-dripping, to contents in excess of the post dripping concentrations reported for Xinjiang by Cao et al. (1994). However, values in excess of the post-dripping results occur in all three study areas and are not restricted to the Wushi area where iodine dripping took place. On the basis of the results of this study, there is no evidence that the iodine-dripping programme carried out in Wushi has increased soil or crop iodine contents beyond levels in other areas, indeed wheat and cabbage contents in Wushi are marginally lower than in the other two study areas (See section 3.4.3.). In this type of environment, adding iodine to irrigation waters is unlikely to be successful over the longer term as the soils contain too little organic matter and Fe and Al oxyhydroxides to retain the iodine for subsequent volatilisation and are too alkaline to allow the ready volatilisation of iodine for plant uptake. Other environmental interventions such as improving the organic matter content of the soil or direct spraying of iodine fertiliser onto plant leaves may prove more successful.

TABLE 5.1 SOIL, WHEAT, CABBAGE AND DRINKING WATER IODINE CONCENTRATIONS FROM THE PRESENT STUDY COMPARED TO OTHER AREAS

Material	Location	Iodine ng/g	Reference
Soil Total I	Xinjiang	300 - 3900	Present Study
Soil Total I	World	4000 - 8000	(Fuge and Johnson, 1986)
Soil Total I	World	5000	(Vinogradov, 1959)
Soil Total I	World	100 – 100 000	(Fuge, 1996)
Soil Total I	World	100 – 72 000	(Johnson, 2003)
Soil Total I	Sri Lanka	130 – 10 000	(Fordyce et al., 2000)
Soil Total I	USA	750	(Shacklette and Boerngen, 1984)
Soil WSol I	Xinjiang	12 - 40	Present Study
Soil WSol I	Wales	300 - 8500	(Johnson, 1980)
Cabbage	Xinjiang	36 – 235	Present Study
Cabbage	Xinjiang Post Iodination	70 - 240	(Jiang et al., 1997)
Cabbage	World	0 - 950	(Barakat et al., 1972)
Cabbage	World	52 – 260	(Chilean Iodine Educational Bureau, 1952)
Cabbage	USA	16 – 791	(Beeson and Matrone, 1972)
Wheat	Xinjiang	32 – 389	Present Study
Wheat	Xinjiang Pre Iodination	32	(Cao et al., 1994)
Wheat	Xinjiang Post Iodination	65 – 94	(Cao et al., 1994)
Wheat	World	37 – 44	(Chilean Iodine Educational Bureau, 1952)
Wheat	Germany	15	(Anke et al., 1993)
Wheat	UK	130	(Food Standards Agency, 2000)
Wheat	Austria	2 - 30	(Shinonaga et al., 2001)
Wheat	Morocco	227	(Aquaron et al., 1993)
Water µg/l	AC148	78 – 100	Present Study
Water µg/l	Wushi + Kuqa	0.1 – 4.05	Present Study
Water µg/l	Xinjiang Pre Iodination	1 - 1.5	(Jiang et al., 1997)
Water µg/l	Xinjiang Post Iodination	7 - 85	(Jiang et al., 1997)
Water µg/l	World	0.01 - 70	(Edmunds and Smedley, 1996)
Water µg/l	World	1.6 - 1270	(Fuge and Johnson, 1986)
Water µg/l	World Low I	3-5	(McClendon and Williams, 1923)
Water µg/l	World IDD	< 20	(Hetzel and Maberly, 1986)
Water µg/l	Heilongjiang IDD	3-9	(Tan, 1989)
Water µg/l	Sri Lanka IDD	3-24	(Fordyce et al., 2000)
Water µg/l	Sri Lanka High I	53-84	(Fordyce et al., 2000)
Water µg/l	Egypt High I	44 – 100	(Fuge, 1989)
Water µg/l	Sri Lanka	1.4 - 450	(Balasuriva et al., 1992)
Water µg/l	China	5 - 50	(Tan, 1989)
Water µg/l	Denmark	2 - 30	(Larsen et al., 1999)
Water µg/l	New Zealand	0.7 – 14.8	(Dean, 1963)
Water µg/l	Morocco	1.08 – 1.19	(Aquaron et al., 1993)
Water µg/l	USA	6.42 – 7.68	(Fuge, 1989)
Water µg/l	Surface Water	< 15	(Fuge and Johnson, 1986)

Although the soil and crop iodine status of all three study areas are similar and explain the historic occurrence of goitre in all three areas, water iodine concentrations show very marked variability between AC148 and the other areas. The surface- and shallow ground- waters used for drinking in Kuqa and Wushi Districts have very low iodine contents (0.1 – 4.05 µg/l) compared to other parts of the world whereas waters abstracted from deep boreholes in the AC148 area contain very high quantities of iodine (78 – 100 µg/l, Table 5.1). On the basis of the dietary information outlined in Table 2.5, the daily intake of iodine from wheat, cabbage and water samples (median values) in the study areas were estimated (Table 5.2). It is clear that high iodine contents of drinking water in the AC148 study area have a significant impact on dietary intakes, which are generous (320 µg/day) by comparison with recommended daily levels (150 – 300 µg/day). In contrast, dietary intakes in the Kuqa and Wushi study areas (139 and 124 µg/day respectively) are below recommended levels despite the iodine-dripping programme carried out in Wushi District (Table 5.2). It should be noted, however, that these results are for three major dietary components only, not for the whole diet and that iodine can be lost from food and water during the storage and cooking process such that raw food content does not necessarily equate to dietary intake. The importance of iodine intake from drinking water and impacts on disease prevalence rates affirm results of previous investigations carried out in Sri Lanka where high iodine drinking waters were also thought to contribute to the lack of IDD in the arid north of the country compared to high IDD rates in south where the climate is much wetter and waters contain little iodine (Fordyce et al., 2000). Similar linkages between low water iodine contents and IDD have been made in India (Longvah and Deosthale, 1998), other areas of China (Tan, 1989) and historically in Australia (Eastman, 1993).

All iodine dietary intake estimates reported in the present study are in excess of the level below which cretinism occurs (25 µg/day (WHO, 1996)). Although historically goitre was a problem in the AC148 area, it is clear that since this former desert region was colonised and developed for agriculture and deep boreholes sunk to provide the water supply, goitre probably ceased to exist in the area. In contrast, the results of the present study indicate that the populations of Kuqa and Wushi are still at risk from iodine deficiency in terms of dietary exposure to natural foodstuffs, however, the assessments of population iodine status also had to take account of the government iodination programmes as follows.

TABLE 5.2 ESTIMATES OF HUMAN DAILY DIETARY IODINE INTAKE FROM WHEAT, CABBAGE AND DRINKING WATER FROM THE PRESENT STUDY

Dietary Composition	Daily Intake Iodine µg		
	AC148	Kuqa	Wushi
Wheat (0.7 kg)	93	90	85
Cabbage (0.4 kg)	43	43	37
Water (2l)	184	6	2
Total	320	139	124
Recommended daily intake (Hetzel and Maberly, 1986)	160 – 200		
Recommended daily intake (WHO, 1996)	150		
Recommended daily intake in goitrogen areas (WHO, 1996)	200 – 300		
Level below which cretinism occurs (WHO, 1996)	25		
Reference nutrient intake UK adults (Food Standards Agency, 2000)	140		
Reference nutrient intake UK children (Food Standards Agency, 2000)	50 – 140		
Average daily intake in the UK (Gregory et al., 1990)	163-226		
Average daily intake in the UK (Food Standards Agency, 2000)	250		
Maximum tolerable daily intake (Food Standards Agency, 2000)	17 µg per kg body weight		

5.2 POPULATION IODINE STATUS

Surveys of the iodine status of a population depend on either clinical markers, such as determination of thyroid size, or on biochemical markers, such as urinary iodine or thyroid hormones. Each of these measures reflects a different set of circumstances, controls and time scales.

In the majority of medical surveys, these population markers have only rarely been determined in conjunction with the iodine status of the local environment and any such environmental measures have usually been limited to a handful of samples of soil or water iodine with little or no interpretation in the light of other factors which may influence them.

However, in the medical literature the iodine status of the environment has often been inferred from the biochemical status of the community. Observations that, several historic endemic areas of IDD are associated with adequate levels of iodine in soil (Fuge, 1996) have usually been discounted as atypical, with the result that the links between environmental iodine and the iodine status of the community have remained unexplored.

The iodine status of a community depends on a number of factors such as the iodine supply, the nutrition of the individual and the community and, sometimes, the presence of goitrogens in the diet. Goitrogens are goitre producing agents, which act within the body to oppose normal iodine metabolism in a variety of ways.

Normally the iodine supply to individuals and the community is from the diet. But in Xinjiang Province there have also been supplies of iodinated oil and salt over the two years prior to the study. These extra sources can seriously alter the local situation.

Daily dietary iodine supply approximately equals the daily loss of iodine in the diet, so measuring urinary iodine is an excellent measure of intake over the last 24 hours, a low output meaning there is a low intake and *vice versa*. The daily intake of iodine can be expected to vary widely in any one individual over the course of many days. However, in a community survey, measuring the iodine intake of a group of people by urinary iodine is a good indicator of the community supply of iodine. When iodised salt is available then the amount of salt used in the day will affect the dietary intake in the same manner in which the intake of crops or water, with their natural supply of iodine, will. Iodised oil is somewhat different, in that it provides a depot within the body from which iodine is constantly released, in an exponentially decreasing fashion.

In the Districts studied here there are important differences in iodine intake, as measured by urinary iodine, at the community level. While the confidence intervals for urinary iodine in Wushi and Kuqa overlap, indicating that the overall intake is similar, AC148 has a significantly higher level of urinary iodine than the other two Districts.

The distribution of urinary iodine varies not only between the communities but within them as well (Table 4.17), particularly in Kuqa where most of the villages have an adequate mean intake. Wuzun, however, has a very low average intake of iodine while Qiman has a high intake. There is far less spread within the villages of Wushi where only 14% have an intake lower than 100 µg/l as against 44% in Kuqa. These differences are further demonstrated by comparison of the mean and median values. The mean and median urinary iodine in AC148 and Wushi are almost exactly the same as each other in both Districts, while in Kuqa there is a large difference between the mean (245 µg/l) and the median (182 µg/l). The spread of values in Kuqa is skewed to the left, with more people with lower values and a few with very high values.

This variation in urinary iodine reflects a difference in the daily iodine supply in the children in the three Districts, including iodised salt, or to the release of iodine from depots of iodised oil. It is likely that the children with the very high intakes of iodine have either been given iodised oil or have a high intake of salt. The low levels of urinary iodine found in both Wushi and Kuqa indicate that there are still people not using iodised salt or who have not been given iodised oil recently. Oral iodised oil capsules can be expected to release iodine for 6-9 months.

There is little environmental evidence for any long-term effect of the irrigation water iodination programme in Wushi but this remains one of the few differences affecting environmental iodine between Wushi and Kuqa and it is tempting to suggest that the water iodination programme may have contributed to fewer people in Wushi, when compared with Kuqa having urinary values below 100 µg/l. However, on the basis of this study, these differences are more likely to be caused by variations in the iodised oil programmes between the two areas.

In most situations, it is generally accepted that between 80 and 90% of the dietary intake of iodine comes from food, with only 10-20% coming from water (atmospheric iodine breathed in accounts for a negligible amount). However, for the present study, estimates of the intake of iodine from wheat and cabbage in the three Districts are very similar (Table 5.2). The main variation in the estimated intake comes from water (see previous section) and is possible that some of the differences within and between the communities are due to the different levels of water iodine and not to the supplementation programmes of salt and oil.

Figure 5.1 demonstrates the similarity in water and urine element distributions between the three study areas but no relationship between soil, wheat or cabbage concentrations and human (urine) I status. Although different numbers of environmental and human urine samples were collected in the three study areas, it is possible to compare these data using median values for each village (Table 5.3). Spearman Rank calculations show that significant (95% CL r_{11} = 0.521, (Koch and Link, 1970)) correlations exist between urinary iodine and fluorine and that correlations between urinary and water iodine and fluorine are almost significant (Table 5.4). Therefore, it is likely that the marked difference in water iodine contents between AC148 and the other two areas does affect the iodine status of the population as indicated by the urinary iodine results. The high urinary I levels in AC148 are also commensurate with the history of very low goitre prevalence.

However, it is a matter of concern that the mean urinary value (464 µg/l) in AC148 is well above the highest recommended threshold (Table 4.17), with over 70% of the children examined having levels over 300 µg/l. Nevertheless, this is not an isolated phenomenon, since about a third to a half of the children in Wushi and Kuqa also have high urinary iodine levels above 300 µg/l, indicating that a potentially toxic intake in these Districts is not uncommon.

Overall, the numbers of persons with urinary iodine exceeding 300 µg/l per day is worrying. It suggests that, in AC148, the naturally high concentrations of iodine in the drinking water are more than sufficient to supply adequate amounts of iodine to the diet without the need to target the population with iodised salt.

There is interplay between nutrition and iodine status, deficiencies in each affecting the other adversely. The main effect of poor nutrition on iodine status is to decrease iodine intake (Fisher, 1996) while the effect of iodine deficiency is to decrease growth hormones (Nazaimoon et al., 1996) with stunted height as a consequence.

The children seen in Xinjiang, whether Han Chinese in AC148 or Uiger children in Wushi and Kuqa Districts were all small for their age by western standards. They were also lighter for their height than western children, as seen by their surface area. Suitable Chinese standards were not readily available for height and weight. There was a clear difference between the slope of the graph of surface area against age in the three areas, indicating that the poorest nutrition was found in Wushi and the best in AC148. This is consistent with the observation of the study team that Wushi is more isolated than Kuqa, which in turn is more isolated than AC148; it is also consistent with the historical differences in goitre prevalence.

It is not easy to unravel the effects of social isolation, which include poor nutrition and stunting, and its related iodine deficiency, which also includes stunting, particularly now that the communities have been heavily supplemented with iodine. However, given the differences between the environmental iodine in the communities it is likely that some of the variance in surface area and height are due to deficiency in iodine.

Thyroid volumes determined during the present study are a more accurate and quantifiable method of measuring goitre than the historical surveys by palpation and visual examination of the neck. The large number of children measured during the present study gives confidence in the accuracy of the results, despite the unknowns of the effects of the recent iodination programmes.

The thyroid volumes in all three areas were lower than those found in iodine replete western children. This is likely to be due to the smaller size of the children and the recent iodination of the community by oral oil capsules, with or without dripping into irrigation waters.

Nevertheless, it is possible to see an underlying trend concordant with the difference in goitre prevalence from pre-iodination days and nutritional status between the three study areas. AC148 had the smallest thyroids, while Wushi had the largest with Kuqa in between. The historical goitre rates were AC148 20%, Kuqa 30% and Wushi 40-60%. Even if the age differences between the children are taken into account (AC148 had the youngest children) there is a real difference in thyroid volume between the three Districts.

Examining the best subset regression equation indicates that there are independent effects on thyroid volume of age, surface area, residence and sex. Adding in thyroid hormones and urinary iodine did not alter the form of the regression. These factors reflect that time is needed to cause thyroid enlargement. Urinary iodine reflects the past 24-hour intake of iodine while hormone levels reflect time on a scale of a few months, perhaps one to three.

The effect of residence, as a reflection of the historical rates, is small since the children are young and have not been exposed to the historical differences in iodine supply in the communities for many years. Visible goitre is unusual in children in any community, so the fact that thyroid volumes by ultrasound detect historical trends is both a comment on the sensitivity of the technique and on the strength of the underlying differences between the communities, despite iodisation programmes.

Another factor that may affect the iodine status of a community is the presence or absence of goitrogens. Only one goitrogen was measured in this study, urinary fluorine, which did not show any trend that could be interpreted as important in the production of goitre.

However, given the paucity of the explanation of variation in thyroid size by the factors in the regression equation it remains a possibility that either there is an unrecognised goitrogen in the province, or, more likely, the study did not measure the correct variables to explain the variation.

Thyroid stimulating hormone (TSH) is produced by the pituitary gland in the base of the brain. TSH levels reflect the effort needed to produce thyroid hormones. Typically the levels are high when the dietary supply of iodine is low and low when iodine supply is high. AC148 had the lowest TSH whilst Wushi had the highest (Table 4.16). This pattern is in accord with the historical goitre picture and with the thyroid volumes measured in this study.

T4 (thyroxine) is the main hormone produced by the thyroid. It does not always reflect the patterns found in TSH and thyroid volumes since, even in the presence of an abnormally low iodine intake it is possible to maintain an adequate secretion of thyroid hormones such as T4.

In this study the differences between the three Districts in the mean values of T4 parallel the surface area means with Kuqa having the lowest values for both and AC 148 the highest (Table 4.15). The Wushi mean was intermediate in both cases. However, there is no correlation between T4 levels and surface area in individuals. As noted earlier, the T4 levels were higher than the threshold for endemic cretinism and no cretins were seen during the present study. Historically, cretinism has been recorded in Aksu County but it was probably of low prevalence.

Our findings support the hypothesis that the origin of the 2D:4D ratio in finger length is in early life. There are differences both between the sexes and between the two ethnic groups. The ethnic differences are much larger than the sex differences.

It is possible that the differences between the Han Chinese children in AC148 and the Uiger children in Wushi and Kuqa Districts in thyroid indices is due to this ethnic difference. The historical distribution of goitre might have been affected by this as well. However, there is little in the literature to indicate ethnic differences in goitre rates. Certainly, the genetic component in iodine deficiency is exceedingly limited. The 2D:4D finger ratio is only partly genetically determined. The early environment plays a large part. So it is likely that the ethnic difference merely reflects the same influences that affect the iodine intake of the children rather than being a separate causal factor. The ratio can thus be seen as strengthening the case for differences between the communities, differences that are likely to be explained by environmental influences.

The association between the masculisation of the individual and lower TSH levels might have significance for the kinds of diseases these individuals are prone to later in life. The 2D:4D ratio correlates with susceptibility to childhood and adult-onset diseases such as heart attacks. What the link between TSH and the ratio is remains unclear, although, as noted above, it is likely to be a common environment. The association may reflect access to nutritious foods in early childhood, since the Uiger communities live further from the centres of civilisation than the AC148 children.

Thus, despite the iodination programmes, two measures (thyroid volumes and TSH) in this study confirm the historical picture and show a gradient of thyroid response between the three Districts.

Classically, this gradient would be interpreted as indicating that the environment is increasingly iodine deficient from AC148 through Kuqa to Wushi District. The standard medical interpretation for such environmental iodine deficiency includes increasing distance from the sea, glaciation 'stripping' the soil, or the presence of limestone (alkaline environments). In this case, distance from the sea is a factor in all three areas but the gradient in goitre prevalence does match increasing alkalinity of the soils from AC148 to Kuqa and Wushi. However, the differences in thyroid volumes most closely reflect the very marked differences in water iodine contents between AC148 and the other two areas and the level of development of the three communities, being greatest in the most remote, least developed area of Wushi and smallest in the more developed AC148 area.

As an indication of iodine status, thyroid volumes in the three study areas were small, by all standards. In AC148, this is confirmation of the natural, adequate intake of iodine and availability of iodised salt. Wushi and Kuqa Districts historically have been iodine deficient. Despite the recent 'double' iodination in Wushi District by oil and the iodine-dripping programme the greater thyroid volumes of the children there reflect a previously poorer iodine supply than in Kuqa.

The iodination programmes in both Wushi and Kuqa Districts have been successful, as seen by the very low thyroid volumes recorded in all the children.

In other words, the diet in AC148 is and has been iodine replete, largely as a result of high iodine intakes in drinking water. In Kuqa District there has been a moderate iodine deficiency, which has been overcome by iodination programmes. Similarly, the iodination programmes in Wushi District have successfully enhanced what was the most deficient diet of the three areas studied. What part in this reduction in Wushi District has been played by orally administered iodine from the government programmes and what part is due to the iodination of the irrigation canals cannot be determined by the medical survey but evidence from the geochemical survey suggests that this environmental intervention has had little long term impact on the iodine status of the soils, crops or drinking water therefore the influence on the population is likely to be small compared to the oral interventions.

These findings are in contrast to the outcomes reported by for iodine dripping programmes in southern Xinjiang Province where it is speculated that iodine added to irrigation waters is effective for up to six years (DeLong, 2002). The discrepancy may be due in part to the different sampling and analytical methods adopted by the two studies and may also reflect differences in soil type between the Wushi area and southern Xinjiang.

However, the difficulties of distinguishing the health effects of the iodine-dripping programme versus those of iodised salt, oil capsule and iodine drinking-water-releaser initiatives are also highlighted in the southern Xinjiang study. The long-term fate of the iodine added to these soils via irrigation water is currently the subject of further investigation by Dr DeLong and his colleagues.

DeLong (2002) compares the economics of different iodination methods. Even if the iodine added in irrigation water is only active for 1 to 2 years it is still a highly cost effective means to increase iodine in the environment (costs 1 Yuan per person for annual irrigation). As Dr DeLong, indicates, it has the added benefit of raising iodine levels in soils, crops, water, animals thus improving crop and animal productivity, which in turn enhance the nutritional status and wealth of as well as the direct benefits of increased iodine in the population. In contrast, other intervention schemes such as the salt (cost 1 – 2 Yuan per person), releasers (cost 2 Yuan each annually) and oil programmes target the population only and do not address the underlying environmental iodine deficiency.

However, it should be noted that most economists would prefer to use marginal rather than average costs, as these are a better indicator of the true price since average costs are easily biased by the inclusion or exclusion of capital and running expenses. To our knowledge, no evaluation of the marginal costs of any type of iodine supplementation programme has been determined.

The present study suggests that the population in the Kuqa and Wushi are at risk from an iodine deficient environment and although the results show that the iodised oil programmes implemented in 1997 and 2000 have successfully reduced IDD, the population will continue to require iodine supplementation in some form well in to the future. Environmental enhancements may prove more beneficial, cost effective and safer as a whole than medical interventions.

TABLE 5.3. MEDIAN IODINE AND FLUORINE CONCENTRATIONS IN SOIL, WATER, WHEAT, CABBAGE AND URINE SAMPLES FROM THE STUDY AREAS.

Area	Village	No.	Soil Total I µg/g	Soil WSol I µg/g	No.	Wheat I µg/100g DW	No.	Cabbage I µg/100g DW	No.	Water I µg/l	Water F mg/l	No.	Urine I µg/l	Urine F mg/l
AC 148	AC 148	25	1.05	0.012	25	13.36	14	10.67	5	92.25	1.10	50	460	1.60
Kuqa	Qiman	5	0.99	0.020	5	13.22	3	7.17	1	3.09	0.76	10	408	2.80
Kuqa	Sandaqiao	5	0.93	0.012	5	10.12	3	7.76	1	3.15	1.93	10	225	0.96
Kuqa	Waqiao	5	1.16	0.012	5	8.03	3	11.84	1	4.05	0.10	12	175	0.64
Kuqa	Wuzun	5	1.00	0.012	5	11.26	3	17.86	1	2.40	0.17	7	33	0.24
Kuqa	Yaha	5	1.65	0.012	5	16.29	3	15.45	1	3.25	0.32	11	150	0.55
Wushi	Aheya	5	1.37	0.012	5	15.68	3	9.35	1	0.10	0.51	10	366	1.06
Wushi	Autebeixi	6	0.70	0.012	5	11.14	3	10.66	1	0.40	0.12	10	356	0.33
Wushi	Daqiao	5	0.62	0.012	5	12.14	3	7.96	1	3.70	0.34	10	286	0.66
Wushi	Wushi Town	5	0.94	0.014	5	15.26	3	8.17	1	0.95	0.17	10	342	1.00
Wushi	Yimamu	5	0.98	0.012	5	12.11	3	17.69	1	2.10	0.21	10	259	0.54

DW = dry weight

TABLE 5.4. SPEARMAN RANK CORRELATION MATRIX OF IODINE AND FLUORINE CONCENTRATIONS IN SOIL, WATER, WHEAT, CABBAGE AND URINE SAMPLES FROM THE STUDY AREAS.

	Soil Total I µg/g	Soil WSol I µg/g	Wheat I µg/g	Cabbage I µg/g	Water I µg/l	Water F mg/l	Urine I µg/l	Urine F mg/l
Soil Total I µg/g	1.000							
Soil WSol I µg/g	-0.080	1.000						
Wheat I µg/g	0.486	0.169	1.000					
Cabbage I µg/g	0.339	-0.412	-0.053	1.000				
Water I µg/l	0.019	-0.119	0.079	-0.052	1.000			
Water F mg/l	-0.036	0.089	-0.100	-0.439	0.353	1.000		
Urine I µg/l	-0.238	0.382	0.321	***-0.649***	0.459	0.237	1.000	
Urine F mg/l	0.023	***0.850***	0.233	***-0.565***	0.305	0.420	***0.642***	1.000

R (11) = 0.521 95% confidence level (Koch and Link, 1970) significant correlations are highlighted in bold

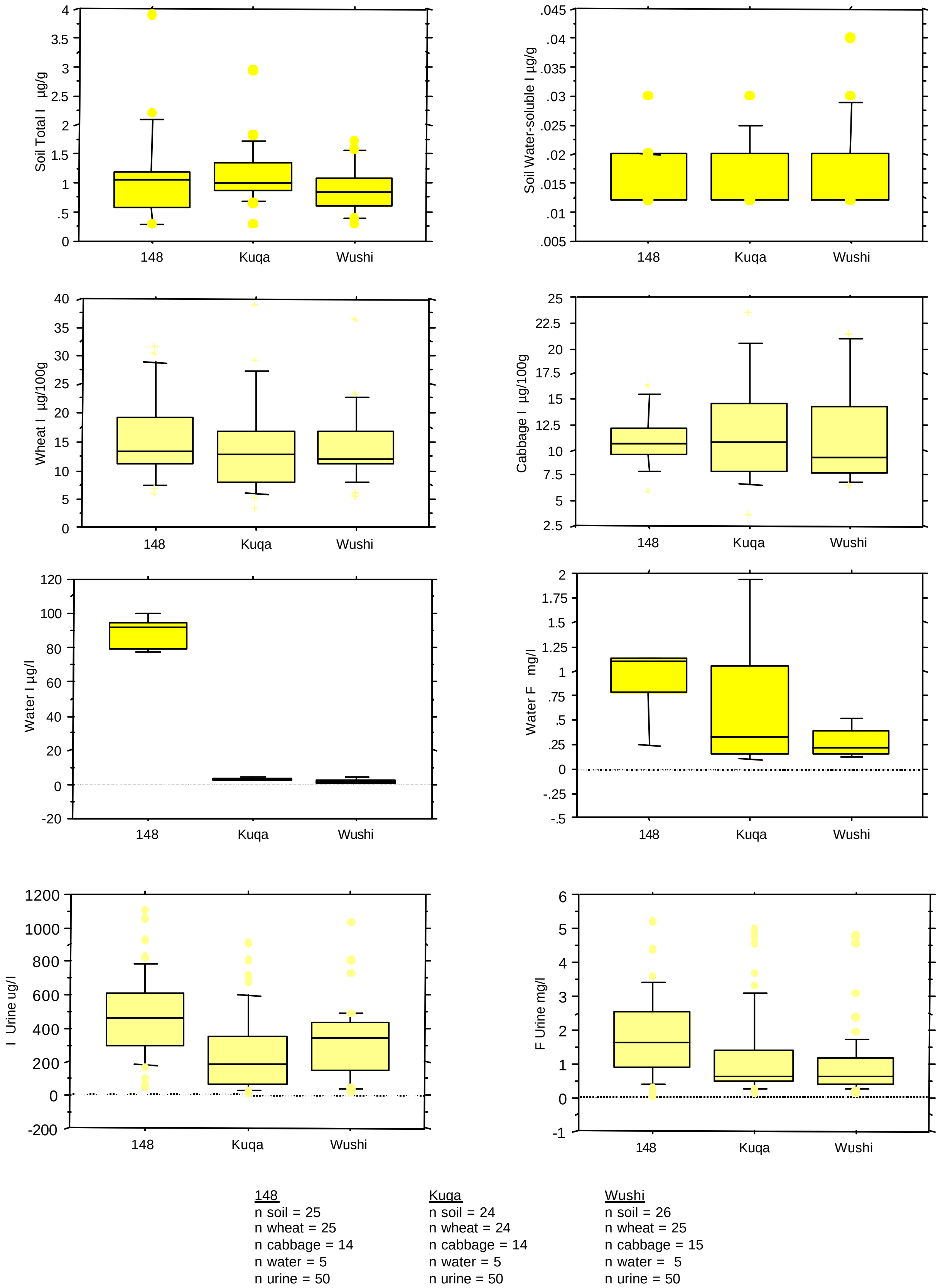


Figure 5.1 Box and whisker plots of the 10th, 25th, 50th, 75th, and 90th percentiles of environmental and health parameter distributions classified by study area.

(148 = no iodine dripping/ low IDD; Kuqa = no iodine dripping/ high IDD; Wushi = iodine dripping/ high IDD)

6 Conclusions and Recommendations

- The results of this study have shown that the iodination programmes carried out in northern Xinjiang Province based on salt, oil and iodine irrigation have been successful in that no goitre prevalence was evident. However, it is not possible to distinguish the efficacy of the iodine irrigation programme alone on the population because of the blanket iodised oil programmes also implemented in the region.

- Environmental investigations demonstrate that the soils and crops of this region are very low in iodine and that the soils do not have the ability to retain iodine added via irrigation water over the longer term. As a result of this environment and the remoteness of the Kuqa and Wushi study areas, the population will remain at risk from iodine deficiency into the future. The question then arises, which is the most efficient means to continue to enhance the iodine status of the population.

- Although iodised salt programmes have proved successful in other areas of the world and are relatively cost effective (1-2 Yuan per person), the take-up in this region is poor for social-economic reasons – the population prefer to use local rock salt rather than iodised salt which has to be purchased in the market.

- Oil iodination programmes have proved successful in Xinjiang but do require major organisation and government intervention and are therefore more expensive than some other measures.

- The water storage jar iodine releasers tested in the region by local authorities previously are also relatively cost effective (2 Yuan each per year) and similar methods of supplementation have proved successful in other parts of the world.

- However, the issue with all these interventions, the salt, oil and iodine-releasers is that they target the human population only without addressing the underlying problem of low environmental iodine.

- It is important to consider environmental interventions because in addition to direct concerns about the human population, increases in the iodine content of soils and plants also improve crop and animal productivity and can therefore enhance the general economic and nutritional well-being of communities contributing to sustainable development.

- Methods to enhance environmental iodine include addition of I-fertilisers to soil but this is only likely to be effective if the soil has the ability to retain iodine and make it available for plant uptake. Since many fertiliser products are of a calcareous nature, adding these to the already alkaline soils of Xinjiang may have the opposite effect and make iodine even less bioavailable. Furthermore, iodine fertilisation is unlikely to be as cost effective as the iodine-irrigation programme trialed in Xinjiang.

- Even if, as the results of this study suggest, the iodine added in irrigation waters is only active for 1 or 2 years it is still a very cost effective method (1 Yuan per person per year). In order to maximise the benefits of this technique, it is recommended that agricultural practices to enhance the retention of soil iodine should be considered and factors that will strongly fix the iodine in the soil and make it unavailable for uptake to crops should be restricted. In Xinjiang, such methods could include the addition of organic matter, for example, ploughing back straw and manure, to the soils to help retain the iodine. It is recommended that the long-term fate of soil iodine added by the irrigation programmes be investigated more fully.

- The importance of iodine in drinking water to the diet is often ignored because in many western countries this source is very minor compared to food. However, the results of this study confirm previous investigations and demonstrate that in subsistence populations consuming low-iodine foodstuffs, water can be an important dietary contributor if supplied from deep groundwater resources, which generally contain much higher concentrations of iodine than surface waters. Thus the provision of deep groundwaters for drinking may prove another useful environmental intervention technique in IDD with the added benefit that groundwaters are generally free of the bacteriological contamination that can affect surface waters. However, any such approach should take account of potential additional water quality problems such as high arsenic or fluoride concentrations prior to groundwater use.

- The results of this study suggest that like many other health effects, the risks of IDD decrease with increased development. For areas of the world where marked economic and social development are unlikely to take place over the shorter term, low-cost environmental interventions could be used along side medical techniques to reduce the risks of IDD provided the political will exists to implement these measures.

- Further investigations into the costs of iodine supplementation programmes are needed. Such studies should take account of benefits other than monetary issues such as the effects of additional iodine on animal and crop productivity, the antibacterial effect of iodine when added to water or other environmental components and possible toxicity in the human and animal population.

7 References

Al-Ajely, K. O., 1985, Biogeochemical prospecting as an effective tool in the search for mineral deposits in Wales: Unpub. Ph.D thesis, University College of Wales Aberystwyth.

Anke, M., Groppel, B., and Bauch, K.-H., 1993, Iodine in the food chain, in Delange, F., Dunn, J. T., and Glinoer, D., eds., Iodine Deficiency in Europe. A Continuing Concern: New York, Plenum Press, p. 151-157.

Aquaron, R., Zarrouck, K., Eljarari, M., Ababou, R., Talibi, A., and Ardissone, J. P., 1993, Endemic Goiter in Morocco - (Skoura-Toundoute Areas in the High Atlas): Journal of Endocrinological Investigation, v. 16, p. 9-14.

Balasuriva, S., Perera, P. A. J., Herath, K. B., Katugampola, S. L., and Fernando, M. A., 1992, Role of iodine content of drinking water in the aetiology of goitre in Sri Lanka: The Ceylon Journal of Medical Science, v. 35, p. 45-51.

Barakat, M. Z., Bassioni, M., and El-Wakil, M., 1972, Bull. Acad. Pol. Sci., v. 20, p. 531.

Bascomb, C., 1964, Rapid method for the determination of cation exchange capacity of calcareous and non-calcareous soils.: Journal of the Science of Food and Agriculture, v. 15, p. 821-823.

Beeson, K. C., and Matrone, G., 1972, Chapter 6: Iodine and Fluorine, The soil factor in nutrition: animal and human, 2. Nutrition and Clinical Nutrition, p. 76-82.

Buchan, I.E., 2002,StatsDirect, StatsDirect Ltd, Cambridge.

Cao, X. Y., Jiang, X. M., Kareem, A., Dou, Z. H., Rakeman, M. A., Zhang, M. L., Ma, T., Odonnell, K., Delong, N., and Delong, G. R., 1994, Iodination of Irrigation Water As a Method of Supplying Iodine to a Severely Iodine-Deficient Population in Xinjiang, China: Lancet, v. 344, p. 107-110.

Cave, M. R., and Green, K. A., 1989, Feasibility study of the determination of iodine, tin, arsenic, selenium and hydrogen carbonate in groundwater by inductively coupled plasma emission spectrometry using a membrane gas-liquid separator: J. Anal. Atom Spectrom, v. 4, p. 223-225.

Chilean Iodine Educational Bureau, 1952, Iodine content of foods: London, Shenval Press.

Dean, G. A., 1963, The iodine content of some New Zealand drinking waters with a note on the contribution of sea spray to the iodine in rain: New Zealand Journal of Science, v. 6, p. 208-214.

DeLong, G. R., 2002, Iodine Dripping into Irrigation Water: Its Role in Correcting Iodine Deficiency: IDD Newsletter, v. November 2002, p. 60-61.

DeLong, G. R., Leslie, P. W., Wang, S. H., Jiang, X. M., Zhang, M. L., Rakeman, M. A., Jiang, J. Y., Ma, T., and Cao, X. Y., 1997, Effect on infant mortality of iodination of irrigation water in a severely iodine-deficient area of China: Lancet, v. 350, p. 771-773.

Eastman, C. J., 1993, The status of iodine nutrition in Australia, in Delange, F., Dunn, J. T., and Glinoer, D., eds., Iodine Deficiency in Europe. A Continuing Concern: New York, Plenum Press, p. 133-138.

Edmunds, W., and Smedley, P., 1996, Groundwater geochemistry and health, in Appleton, J. D., Fuge, R., and McCall, G., eds., Environmental Geochemistry and Health with Particular Reference to Developing Countries, 113. Special Publication: London, Geological Society of London, p. 91-105.

Fisher, D.A., 1996, Physiological variations in thyroid hormones: Physiological and pathophysiological considerations. Clinical Chemistry v. 42(1), p. 135-139

Food Standards Agency, 2000, 1997 Total Diet Study - Fluoride, Bromine and Iodine, Food Surveillance, 5/00.

Fordyce, F., M., Johnson, C. C., Navaratne, U. R. B., Appleton, J. D., and Dissanayake, C. B., 1998, Studies of Selenium Geochemistry and Distribution in Relation to Iodine Deficiency Disorders in Sri Lanka.: Keyworth, British Geological Survey.

Fordyce, F. M., Johnson, C. C., Navaratne, U. R. B., Appleton, J. D., and Dissanayake, C. B., 2000, Selenium and iodine in soil, rice and drinking water in relation to endemic goitre in Sri Lanka: The Science of the Total Environment, v. 263, p. 127-141.

Fuge, R., 1989, Iodine in waters; possible links with endemic goitre: Applied Geochemistry, v. 4, p. 203-208.

Fuge, R., 1996, Geochemistry of iodine in relation to iodine deficiency diseases, in Appleton, J. D., Fuge, R., and McCall, G. J. H., eds., Environmental Geochemistry and Health, 113: London, Geological Society Special Publication, p. 201-211.

Fuge, R., and Johnson, C. C., 1986, The Geochemistry of Iodine - a Review: Environmental Geochemistry and Health, v. 8, p. 31-54.

Fuge, R., Johnson, C. C., and PhilIips, W. J., 1978, Iodine in granitic and associated rocks: Chemical Geology, v. 22, p. 347-352.

Gregory, J., Foster, K., Tyler, H., and Wiseman, M., 1990, The Dietary and Nutritional Survey of British Adults: London, HMSO.

Hetzel, B. S., and Maberly, G. F., 1986, Iodine, in Mertz, W., ed., Trace Elements in Human and Animal Nutrition, 2, Academic Press, p. 139-208.

Jiang, X. M., Cao, X. Y., Jiang, J. Y., Ma, T., James, D. W., Rakeman, M. A., Dou, Z. H., Mamette, M., Amette, K., Zhang, M. L., and DeLong, G. R., 1997, Dynamics of environmental supplementation of iodine: Four years' experience of iodination of irrigation water in Hotien, Xinjiang, China: Archives of Environmental Health, v. 52, p. 399-408.

Johnson, C. C., 1980, The geochemistry of iodine and a preliminary investigation into its potential use as a pathfinder element in geochemical exploration: PhD thesis, University College of Wales, Aberystwyth.

Johnson, C. C., 2003, Database of the iodine content of soils populated with data from published literature: Keyworth, Nottingham, British Geological Survey.

Johnson, C. C., Ge, X., Green, K. A., and Liu, X., 2000, Selenium distribution in the local environment of selected villages of the Keshan Disease belt, Zhangjiakou District, Hebei Province, People's Republic of China.: Applied Geochemistry, v. 15, p. 385-401.

Koch, G., and Link, R., 1970, Statistical Analysis of Geological Data: New York, John Wiley and Sons.

Larsen, E. H., Knuthsen, P., and Hansen, M., 1999, Seasonal and regional variations of iodine in Danish dairy products determined by inductively coupled plasma mass spectrometry: Journal of Analytical Atomic Spectrometry, v. 14, p. 41-44.

Li, J., and Wu, G., 1999, Atlas of the Ecological Environmental Geochemistry of China: Beijing, Geological Publishing House.

Longvah, T., and Deosthale, Y. G., 1998, Iodine content of commonly consumed foods and water from the goitre- endemic northeast region of India: Food Chemistry, v. 61, p. 327-331.

Marine, D., and Kimball, O. P., 1920, Prevention of simple goiter in man: Arch. Intern. Med., v. 25, p. 661-672.

McClendon, J. F., and Williams, A., 1923, Simple goitre as a result of iodine deficiency: Journal American Medical Association, v. 80, p. 600-601.

Muramatsu, Y., Uchida, S., Sumiya, M., and Ohmomo, Y., 1985, Iodine Separation Procedure For the Determination of I-129 and I-127 in Soil By Neutron-Activation Analysis: Journal of Radioanalytical and Nuclear Chemistry, v. 94, p. 329-338.

Nakahara, T., and Mori, T., 1994, Analyte volatilisation for the determination of low concentrations of iodine by inductively coupled plasma atomic emission spectrometry: Journal of Analytical Atomic Spectrometry, v. 9, p. 159-164.

Nazaimoon, W.M.W., Osman, A., Wu, L.L. and Khalid, B.A.K., 1996, Effects of iodine deficiency on insulin-like growth factor-I, insulin-like growth factor-binding protein-3 levels and height attainment in malnourished children., Clinical Endocrinology, v. 45(1), p. 79-83

Shacklette, H. T., and Boerngen, J. G., 1984, Element concentrations in soils and other surficial materials of the conterminous United States, US Geological Survey.

Shaohua, W., and DeLong, G. R., 2000, The final Report of the expanded Iodine Dripping Project in Xinjiang Uygur Autonomous Region 1997-1999: Urumchi, Xinjiang Health Bureau.

Shinonaga, T., Gerzabek, M. H., Strebl, Y., and Muramatsu, Y., 2001, Transfer of iodine from soil to cereal grains in agricultural areas of Austria: The Science of the Total Environment, v. 267, p. 33-40.

Tan, J., 1989, The Atlas of Endemic Diseases and Their Environments in the People's Republic of China.: Beijing, Science Press.

Vinogradov, A. P., 1959, The Geochemistry of Rare and Dispersed Chemical elements in Soils: New York, Consultants Bureau.

Whitehead, D. C., 1984, The distribution and transformations of iodine in the environment: Environment International, v. 10, p. 321-339.

WHO, 1996, Trace Elements in Human Nutrition and Health: Geneva, WHO.

APPENDIX A. SUMMARY INFORMATION FOR THE 15 STUDY VILLAGES

Area Code	Area Name	Village Name	Population of Village	School Name	Longitude of School	Latitude of School
1- Low IDD/ no I dripping	AC148	Village 3	400	148 Primary	86.30832	44.85051
1- Low IDD/ no I dripping	AC148	Village 21	500	148 Primary	86.30832	44.85051
1- Low IDD/ no I dripping	AC148	Village 2	1100	148 Primary	86.30832	44.85051
1- Low IDD/ no I dripping	AC148	Village 4	2000	148 Primary	86.30832	44.85051
1- Low IDD/ no I dripping	AC148	Village 6	1000	148 Primary	86.30832	44.85051
2 - High IDD/ no I dripping	Kuqa	Qiman	33 000 (area) 2600 (village)	Qiman Primary	82.89593	41.52012
2 - High IDD/ no I dripping	Kuqa	Sandaqiao	5500 (area) 484 (village)	Sandaqiao Primary	82.75428	41.64926
2 - High IDD/ no I dripping	Kuqa	Yaha	240	Yaha Primary	83.23561	41.74297
2 - High IDD/ no I dripping	Kuqa	Wuzun	500	Wuzun Primary	83.05934	41.68706
2 - High IDD/ no I dripping	Kuqa	Waqiao	1670	Waqiao Primary	82.89330	41.69552
3 - High IDD/ I dripping	Wushi	Aheya	30 000	Aheya Primary	79.70520	41.21262
3 - High IDD/ I dripping	Wushi	Daqiao	15959	Daqiao Primary	79.42725	41.20714
3 - High IDD/ I dripping	Wushi	Wushi Town	30 000 (area) 4000 (town)	Wushi Town Primary	79.22566	41.21069
3 - High IDD/ I dripping	Wushi	Autebeixi	20 000	Autebeixi Primary	79.13452	41.18071
3 - High IDD/ I dripping	Wushi	Yimamu	17500	Yimamu Primary	79.45888	41.26902

APPENDIX B. LISTING OF SOIL RESULTS

Appendix B.1 Soil Field Data

Sample Number	Area Name	Location	Longitude	Latitude	Field Colour	Soil Texture	Sampling Depth (m)	Soil Clasts	Comments
UR1	148	Village 2	86.34332	44.81329	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest.
UR27	148	Village 2	86.33967	44.81452	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR33	148	Village 2	86.34333	44.82029	LB	Clay-Silt	0.10	None	Cotton field, previous crop = wheat. Soil is damp, been irrigated.
UR66 (Dup B1)	148	Village 2	86.33828	44.81547	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR71 (Dup A1)	148	Village 2	86.33828	44.81547	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR87	148	Village 2	86.33876	44.81489	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR13	148	Village 21	86.29671	44.81384	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest. Straw ploughed into field.
UR22	148	Village 21	86.29474	44.81539	LB	Silt	0.10	None	Cotton field, previous crop = wheat
UR62	148	Village 21	86.29687	44.81376	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR84	148	Village 21	86.29526	44.81243	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR89	148	Village 21	86.29688	44.81287	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR5	148	Village 3	86.30249	44.85463	LB	Silt	0.10	None	Cotton field, previous crop = wheat
UR37	148	Village 3	86.29543	44.84878	LB	Silt	0.10	None	Harvested wheat field now with cabbage crop to S of village. Soil is damp, been irrigated.
UR75	148	Village 3	86.32156	44.84854	LB	Silt	0.10	None	Harvested wheat field now with cabbage crop. To E of village
UR83	148	Village 3	86.30329	44.85572	LB	Silt	0.10	None	Ploughed field beside main road from 148 to village. Previous crop = wheat. current crop = sunflowers. Animal fertiliser on field
UR99	148	Village 3	86.31927	44.84941	LB	Silt	0.10	None	Harvested wheat field now with cabbage crop to E of village
UR11	148	Village 4	86.29101	44.87255	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR14	148	Village 4	86.29030	44.87348	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR39	148	Village 4	86.28722	44.87415	LB	Clay-Silt	0.10	None	Cotton field, previous crop = wheat.
UR79	148	Village 4	86.29530	44.86791	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest, sunflower stalks ploughed into field
UR93	148	Village 4	86.29101	44.87334	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR10	148	Village 6	86.30645	44.88418	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.

Sample Number	Area Name	Location	Longitude	Latitude	Field Colour	Soil Texture	Sampling Depth (m)	Soil Clasts	Comments
UR20	148	Village 6	86.30557	44.88440	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR21	148	Village 6	86.30277	44.88500	LB-GY	Clay-Silt	0.10	None	Ploughed wheat and sunflower field after harvest.
UR24	148	Village 6	86.33062	44.87889	LB	Clay	0.10	None	Cotton field, previous crop = wheat. Soil is damp, been irrigated.
UR44	148	Village 6	86.30494	44.88451	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR29	Kuqa	Qiman	82.92020	41.51246	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest
UR58	Kuqa	Qiman	82.92376	41.51496	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest
UR59	Kuqa	Qiman	82.92069	41.51225	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR88	Kuqa	Qiman	82.93928	41.51042	LB-R	Clay	0.08	Sltst	Harvested wheat field now with new wheat crop.
UR90	Kuqa	Qiman	82.93948	41.51140	LB-R	Clay-Silt	0.08	Sltst	Harvested wheat field now with new wheat crop.
UR15	Kuqa	Sandaqiao	82.76102	41.63218	LB-OR	Silt	0.08	None	Ploughed wheat field after harvest
UR45	Kuqa	Sandaqiao	82.76224	41.62607	LB-OR	Clay-silt	0.10	None	Harvested wheat field now with new wheat crop.
UR50	Kuqa	Sandaqiao	82.76244	41.03225	LB-OR	Silt	0.08	Sltst	Harvested wheat field now with new wheat crop.
UR57	Kuqa	Sandaqiao	82.77062	41.61944	LB-OR	Clay-Silt	0.10	None	Harvested wheat field now with new wheat crop.
UR77	Kuqa	Sandaqiao	82.75656	41.63069	LB-R	Silt	0.08	None	Harvested wheat field now with new wheat crop.
UR7 (Dup B3)	Kuqa	Waqiao	82.95064	41.69511	LB-R	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop.
UR28 (Dup A3)	Kuqa	Waqiao	82.95064	41.69511	LB-R	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop.
UR49	Kuqa	Waqiao	82.96382	41.68739	LB-R	Clay-Silt	0.10	Sltst, lst, coal	Harvested wheat field now with cabbage crop.
UR55	Kuqa	Waqiao	82.95312	41.69402	LB-R	Clay-Silt	0.10	Sltst, lst	Harvested wheat field now with pea crop.
UR78	Kuqa	Waqiao	82.95242	41.69412	LB-R	Clay-Silt	0.10	Sltst, coal	Ploughed wheat field after harvest.
UR100	Kuqa	Waqiao	82.95005	41.69534	LB-R	Clay-Silt	0.10	Sltst, lst	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR9	Kuqa	Wuzun	83.06312	41.67757	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field now with cabbage crop.
UR31	Kuqa	Wuzun	83.05798	41.67846	LB-R	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop.
UR40	Kuqa	Wuzun	83.05771	41.67667	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field after harvest.
UR69	Kuqa	Wuzun	83.05751	41.67751	LB-R	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop.
UR70	Kuqa	Wuzun	83.06312	41.67766	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field after harvest.
UR26	Kuqa	Yaha	83.28368	41.75003	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field after harvest.
UR46	Kuqa	Yaha	83.28301	41.75100	LB-R	Clay-Silt	0.10	Sltst	Harvested wheat field now with new wheat crop.

Sample Number	Area Name	Location	Longitude	Latitude	Field Colour	Soil Texture	Sampling Depth (m)	Soil Clasts	Comments
UR48	Kuqa	Yaha	83.27235	41.74760	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field after harvest.
UR67	Kuqa	Yaha	83.27130	41.74716	LB-R	Clay-Silt	0.08	Sltst	Ploughed wheat field after harvest.
UR85	Kuqa	Yaha	83.28353	41.74937	LB-R	Clay-Silt	0.10	Sltst	Ploughed wheat field after harvest.
UR36	Wushi	Aheya	79.66796	41.20408	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest.
UR38	Wushi	Aheya	79.67975	41.20124	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR61	Wushi	Aheya	79.67988	41.19744	LB-GY-YE	Clay-Silt	0.10	None	Harvested wheat field now with cabbage and grass crops
UR65	Wushi	Aheya	79.66699	41.20325	LB	Clay-Silt	0.10	None	Ploughed wheat field after harvest.
UR74	Wushi	Aheya	79.67197	41.19485	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage and new wheat crops
UR41	Wushi	Autebeixi	79.15717	41.17253	LB	Silt	0.10	None	Ploughed wheat field after harvest.
UR82	Wushi	Autebeixi	79.13145	41.18076	LB	Clay-Silt	0.08	Mdst, sltst	Ploughed wheat field after harvest to E of dirt track. Soils irrigated with iodine water 2 years ago.
UR16	Wushi	Autebeixi	79.15801	41.17300	LB	Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR23	Wushi	Autebeixi	79.15255	41.17687	LB	Silt	0.10	None	Cabbage field next to house.
UR23 (2)	Wushi	Autebeixi	79.15094	41.17900	LB	Silt	0.10	None	Ploughed wheat field after harvest separate to house
UR76	Wushi	Autebeixi	79.15899	41.17173	LB-GY	Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR6	Wushi	Daqiao	79.44982	41.20461	LB-GY	Clay-Silt	0.10	None	Ploughed wheat field after harvest.
UR18	Wushi	Daqiao	79.45909	41.22694	LB	Silt	0.10	None	Ploughed wheat field after harvest.
UR25	Wushi	Daqiao	79.45084	41.21843	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR42	Wushi	Daqiao	79.45208	41.21887	LB	Clay-Silt	0.10	None	Harvested wheat field now with maize crop.
UR81	Wushi	Daqiao	79.49645	41.22684	LB	Clay-Silt	0.10	None	Harvested wheat field now with maize crop.
UR17	Wushi	Wushi Town	79.20022	41.20279	LB-YE	Clay-Silt	0.10	None	Harvested wheat field now with c hickpea crop.
UR30 (Dup B2)	Wushi	Wushi Town	79.19675	41.20609	LB	Clay	0.10	Sltst	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR54 (Dup A2)	Wushi	Wushi Town	79.19675	41.20609	LB	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop. Soil is damp, been irrigated.
UR73	Wushi	Wushi Town	79.19227	41.20684	LB-YE	Clay-Silt	0.08	Sltst	Harvested wheat field under orchard.
UR97	Wushi	Wushi Town	79.19541	41.20452	LB	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage crop.
UR98	Wushi	Wushi Town	79.19785	41.20496	LB	Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR4	Wushi	Yimamu	79.44896	41.25358	LB-GY	Clay-Silt	0.10	None	Harvested wheat field now with new wheat crop.

Sample Number	Area Name	Location	Longitude	Latitude	Field Colour	Soil Texture	Sampling Depth (m)	Soil Clasts	Comments
UR72	Wushi	Yimamu	79.44603	41.25198	LB	Clay-Silt	0.10	None	Harvested wheat field now with new wheat crop.
UR80	Wushi	Yimamu	79.45091	41.25699	LB	Clay-Silt	0.10	Sltst	Harvested wheat field now with cabbage and maize crop.
UR92	Wushi	Yimamu	79.45427	41.25730	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage and maize crop. Soil is damp, been irrigated.
UR94	Wushi	Yimamu	79.45720	41.25583	LB	Clay-Silt	0.10	None	Harvested wheat field now with cabbage crop.
UR35	Wushi	R. Tuoshigan	79.71754	41.21993	LB-YE	Sand	0.10	Mdst, sltst, sst, qtz, grdior	Grass field on riverbank N of Aheya.
UR43	Wushi	R. Tuoshigan	79.16931	41.24976	LB-YE	Sand	0.10	Mdst, sltst, sst, qtz, grdior	Grass field on river bank N of Wushi
UR52	Wushi	R. Tuoshigan	79.10217	41.20770	LB-YE	Sand	0.10	Mdst, sltst, sst, qtz, grdior	River terrace at Autebeixi power plant iodine dripping site
UR56	Wushi	R. Tuoshigan	79.46812	41.32035	LB-YE	Sand-Silt	0.10	Mdst, sltst, sst, qtz, grdior	River terrace N of Yimamu
UR64	Wushi	R. Tuoshigan	78.98192	41.14431	LB-YE	Sand-Silt	0.08	Mdst, sltst, sst, qtz, grdior	Junction of aqueduct (concrete) and stream at village with tombs W of Autebeixi, water is from river. Goats grazing.
UR86	Wushi	R. Tuoshigan	78.95720	41.11892	LB-OR	Fine sand	0.05	Mdst, sltst, sst, qtz, grdior	250 m east of aqueduct on river alluvium. Goats grazing.
UR95	Wushi	R. Tuoshigan	79.78012	41.17254	LB	Sand-Silt	0.10	None	River terrace E of Aheya. Soil has 4 mm thick salt crust.
UR Rock Salt 'White'	Kuqa	Kuqa Mine	82.88977	41.90721					Sample collected from mine
UR Rock Salt 'Grey'	Kuqa	Kuqa Mine	82.88977	41.90721					Sample collected from mine
UR Coal	Kuqa	Kuqa Town							Sample collected from road-side coal pile

LB = Light Brown, R = Red, YE = Yellow, GY = Grey, OR = Orange   Sltst = siltstone, Sst = sandstone, Lst = limestone, Mdst = mudstone, Qtz = quartz, Grdior = granodiorite

Dup = Field Duplicate   SS = Sub-sample

Appendix B.2. Soil Chemical Element Determinations

(Al, Fe, Ca, Mg, Mn, Cu, Ni, Se - IRMA laboratories Beijing) (I, Water Soluble I - BGS laboratories Keyworth)

LIMS ID	Sample Number	Al wt%	Fe wt%	Ca wt%	Mg wt%	Mn µg/g	Cu µg/g	Ni µg/g	Zn µg/g	Se µg/g	I µg/g	WSol I µg/g
06873-00001	UR1	6.25	2.70	4.71	1.28	580.00	24.00	19.00	60.00		0.85	<0.020
06873-00002	UR4	5.17	2.64	9.81	2.03	577.00	24.00	22.00	71.00	0.35	0.98	<0.020
06873-00003	UR5	6.32	2.63	4.76	1.23	595.00	24.00	19.00	67.00		1.16	0.030
06873-00004	UR6	4.87	2.29	10.64	2.72	533.00	22.00	18.00	69.00	0.44	0.46	<0.020
06873-00005	UR7 Dup B3	5.99	2.89	9.52	1.59	661.00	28.00	22.00	72.00	0.28	1.40/0.99	0.020/<0.020
06873-00006	UR8 SS B2	5.47	2.77	9.76	1.94	596.00	30.00	22.00	80.00		0.69	<0.020
06873-00007	UR9	5.61	2.69	8.64	1.44	638.00	25.00	21.00	65.00		0.85	<0.020
06873-00008	UR10	6.73	3.12	2.56	1.27	613.00	28.00	19.00	72.00		0.77	<0.020
06873-00009	UR11	7.08	2.82	3.75	1.23	574.00	27.00	19.00	64.00		0.67	<0.020
06873-00010	UR13	6.35	2.70	3.63	1.22	611.00	23.00	21.00	60.00	0.17	<0.5	<0.020
06873-00011	UR14	7.17	3.02	3.87	1.36	595.00	29.00	21.00	72.00	0.21	0.36	0.020
06873-00012	UR15	4.48	1.91	12.74	1.97	494.00	22.00	16.00	50.00		<0.5	0.020/0.030
06873-00013	UR16	5.47	2.77	9.96	1.88	567.00	29.00	21.00	72.00		0.5/<0.5	0.030
06873-00014	UR17	5.50	2.79	9.62	1.91	580.00	35.00	22.00	77.00	0.51	0.49	0.030
06873-00015	UR18	5.17	2.59	10.59	2.47	553.00	26.00	22.00	73.00	0.48	0.62	<0.020
06873-00016	UR19 SS A2	5.44	2.77	9.81	1.93	599.00	26.00	22.00	80.00		0.71	<0.020
06873-00017	UR20	7.25	3.22	2.59	1.38	627.00	27.00	20.00	78.00		<0.5	<0.020
06873-00018	UR21	6.80	3.08	2.54	1.34	583.00	28.00	21.00	72.00		0.59	<0.020
06873-00019	UR22	5.28	2.52	3.57	1.28	563.00	24.00	22.00	60.00		1.17	<0.020
06873-00020	UR23	5.76	2.90	10.50	1.99	648.00	46.00	23.00	78.00	0.29	0.99	<0.020
06873-00021	UR23 (2)	5.41	2.73	10.04	1.88	572.00	23.00	23.00	72.00		0.78	<0.020
06873-00022	UR24	7.40	3.90	4.13	1.64	775.00	32.00	26.00	91.00	0.19	0.87/0.96	<0.020
06873-00023	UR25	5.46	2.77	10.86	2.42	557.00	33.00	21.00	70.00		0.39	<0.020
06873-00024	UR26	5.66	2.85	9.12	1.57	666.00	27.00	24.00	69.00		0.65	<0.020
06873-00025	UR27	7.25	3.40	5.14	1.56	665.00	28.00	29.00	79.00		1.17	<0.020
06873-00026	UR28 Dup A3	6.01	2.92	9.68	1.59	687.00	31.00	27.00	97.00	0.22	1.16	<0.020/<0.020
06873-00027	UR29	5.22	2.59	12.18	2.38	608.00	32.00	24.00	69.00		0.99	0.030
06873-00028	UR30 Dup B2	5.54	2.84	10.11	1.97	606.00	29.00	24.00	85.00		0.44	<0.020
06873-00029	UR31	5.84	2.85	9.12	1.50	665.00	27.00	23.00	68.00		1.27/1.41	<0.020
06873-00030	UR33	6.55	2.86	4.19	1.23	566.00	26.00	21.00	69.00		1.05	<0.020
06873-00031	UR34 SS B1	6.56	3.06	4.40	1.39	584.00	26.00	25.00	72.00		1.88	<0.020
06873-00032	UR35	3.87	1.92	11.15	1.52	417.00	21.00	15.00	44.00		1.14	<0.020
06873-00033	UR36	5.77	3.01	10.94	2.54	629.00	27.00	24.00	79.00		0.72	<0.020/<0.020
06873-00034	UR37	6.08	2.89	5.04	1.40	663.00	24.00	21.00	70.00		3.90	<0.020
06873-00035	UR38	5.16	2.90	11.17	2.56	612.00	24.00	24.00	71.00	0.24	0.73	<0.020/<0.020
06873-00036	UR39	6.01	2.87	3.58	1.19	566.00	25.00	21.00	68.00		1.27	<0.020
06873-00037	UR40	5.61	2.77	8.82	1.43	652.00	31.00	23.00	65.00		1.00	<0.020
06873-00038	UR41	5.46	2.83	10.17	1.84	592.00	29.00	24.00	73.00		<0.5	<0.020
06873-00039	UR42	5.03	2.82	10.63	2.31	559.00	27.00	23.00	75.00		0.59/0.69	<0.020
06873-00040	UR43	4.53	2.18	10.51	1.48	495.00	23.00	17.00	51.00		0.57	<0.020

LIMS ID	Sample Number	Al wt%	Fe wt%	Ca wt%	Mg wt%	Mn µg/g	Cu µg/g	Ni µg/g	Zn µg/g	Se µg/g	I µg/g	WSol I µg/g
06873-00041	UR44	5.72	3.09	2.49	1.42	585.00	30.00	22.00	85.00	0.21	0.86	<0.020
06873-00042	UR45	5.00	2.16	12.99	1.86	534.00	20.00	18.00	57.00		1.13	<0.020
06873-00043	UR46	5.83	2.95	9.05	1.61	668.00	28.00	24.00	70.00	0.21	1.65	<0.020
06873-00044	UR47 IS GBW07402										1.42	0.020
06873-00045	UR48	5.73	2.71	9.81	1.58	676.00	25.00	24.00	74.00	0.24	1.72	<0.020
06873-00046	UR49	6.04	2.82	9.82	1.56	692.00	31.00	24.00	76.00		2.93	<0.020
06873-00047	UR50	5.02	2.25	13.42	1.96	554.00	27.00	17.00	62.00		0.96	<0.020/<0.020
06873-00048	UR51 SS B3	5.76	2.91	9.45	1.52	670.00	40.00	24.00	72.00		0.91	0.020
06873-00049	UR52	4.46	2.16	10.43	1.36	499.00	31.00	18.00	49.00		<0.5	<0.020
06873-00050	UR53 SS A3	5.78	2.96	9.79	1.54	671.00	27.00	25.00	72.00		0.40	0.020
06873-00051	UR54 Dup A2	5.43	2.85	10.20	1.96	622.00	29.00	23.00	83.00		0.60	0.020/0.020
06873-00052	UR55	5.74	2.85	9.22	1.49	661.00	53.00	22.00	71.00		1.16	0.030
06873-00053	UR56	4.12	2.04	12.86	1.98	449.00	20.00	15.00	47.00		0.47	0.030
06873-00054	UR57	5.23	2.36	13.19	2.07	479.00	20.00	18.00	59.00	0.25	0.93	0.020
06873-00055	UR58	5.43	2.84	11.88	2.34	638.00	28.00	24.00	76.00		0.83/1.18	0.020
06873-00056	UR59	5.21	2.61	12.91	2.34	634.00	23.00	23.00	69.00	0.35	0.82	<0.020
06873-00057	UR60 SS A1	6.86	3.09	4.51	1.37	605.00	27.00	26.00	72.00		1.60	<0.020
06873-00058	UR61	5.54	2.97	11.27	2.60	631.00	25.00	23.00	76.00		1.58	0.040
06873-00059	UR62	6.67	2.78	3.67	1.22	626.00	26.00	21.00	62.00		1.54	<0.020
06873-00060	UR64	5.36	2.87	9.53	1.88	621.00	27.00	24.00	69.00		2.11	<0.020
06873-00061	UR65	5.16	2.79	10.74	2.35	589.00	23.00	22.00	68.00	0.29	1.96/1.22	<0.020
06873-00062	UR66 Dup B1	7.00	3.28	4.61	1.40	619.00	29.00	27.00	76.00	0.21	2.75	<0.020
06873-00063	UR67	5.00	2.51	8.79	1.34	606.00	25.00	20.00	61.00		1.67	<0.020
06873-00064	UR69	5.78	2.87	9.34	1.46	686.00	26.00	24.00	70.00	0.24	1.83	<0.020
06873-00065	UR70	5.64	2.81	9.28	1.42	669.00	27.00	22.00	68.00	0.20	0.86	<0.020
06873-00066	UR71 Dup A1	6.22	3.10	4.54	1.34	606.00	28.00	27.00	75.00	0.19	1.58	<0.020
06873-00067	UR72	5.39	2.93	10.67	2.14	634.00	31.00	24.00	79.00	0.44	0.89	<0.020
06873-00068	UR73	5.33	2.82	9.79	1.81	607.00	24.00	22.00	73.00	0.29	1.73	0.020
06873-00069	UR74	5.16	2.72	11.08	2.41	578.00	22.00	20.00	76.00		1.37	0.020
06873-00070	UR75	6.72	3.12	4.78	1.39	666.00	24.00	18.00	75.00	0.20	0.91/1.33	0.020
06873-00071	UR76	5.25	2.80	10.26	1.80	586.00	26.00	23.00	71.00		0.97	<0.020
06873-00072	UR77	4.43	1.84	12.92	1.66	464.00	16.00	14.00	49.00	0.16	0.68	<0.020
06873-00073	UR78	5.84	2.98	9.48	1.52	689.00	29.00	26.00	72.00		1.03	<0.020
06873-00074	UR79	5.63	2.68	2.79	1.11	499.00	26.00	18.00	66.00	0.30	0.53	0.020
06873-00075	UR80	5.47	2.88	11.04	2.07	615.00	28.00	22.00	75.00		0.61	<0.020
06873-00076	UR81	6.06	3.21	11.83	2.50	677.00	27.00	27.00	88.00		1.16	<0.020
06873-00077	UR82	5.74	3.07	11.01	2.03	637.00	30.00	25.00	82.00	0.25	0.58/0.66	0.020
06873-00078	UR83	5.69	2.78	4.36	1.19	598.00	26.00	19.00	69.00		0.50	0.020
06873-00079	UR84	5.68	2.95	4.17	1.34	686.00	13.00	27.00	69.00		<0.5	0.020
06873-00080	UR85	5.80	2.93	9.82	1.53	695.00	25.00	24.00	71.00		1.05	0.020
06873-00081	UR86	4.41	2.36	10.85	1.45	555.00	20.00	17.00	51.00		0.45	0.020
06873-00082	UR87	7.45	3.53	5.14	1.52	684.00	35.00	30.00	88.00		2.21	0.020
06873-00083	UR88	5.20	2.60	13.75	2.40	638.00	24.00	22.00	67.00	0.29	0.75	<0.020
06873-00084	UR89	6.91	2.90	3.99	1.30	668.00	23.00	24.00	65.00	0.14	1.14	<0.020

LIMS ID	Sample Number	Al wt%	Fe wt%	Ca wt%	Mg wt%	Mn µg/g	Cu µg/g	Ni µg/g	Zn µg/g	Se µg/g	I µg/g	WSol I µg/g
06873-00085	UR90	5.24	2.67	13.31	2.39	654.00	28.00	24.00	69.00		1.36	0.020
06873-00086	UR92	5.59	2.95	11.57	2.22	628.00	26.00	25.00	88.00		1.09	0.020
06873-00087	UR93	6.20	3.19	3.91	1.32	631.00	36.00	22.00	78.00		1.05/1.19	0.020
06873-00088	UR94	5.34	2.77	10.66	1.93	599.00	26.00	23.00	75.00		1.39	<0.020
06873-00089	UR95	4.46	2.23	11.70	1.65	498.00	20.00	17.00	51.00		0.73	0.030
06873-00090	UR96 IS GBW07402										1.59	<0.020
06873-00091	UR97	5.15	2.70	10.64	1.76	584.00	28.00	21.00	72.00		0.94	<0.020
06873-00092	UR98	5.29	2.84	10.28	1.84	627.00	27.00	22.00	81.00		1.04	<0.020
06873-00093	UR99	6.89	3.06	5.53	1.40	697.00	33.00	20.00	82.00	0.17	2.08	<0.020
06873-00094	UR100	6.02	3.01	10.16	1.51	696.00	31.00	23.00	73.00		1.37	<0.020
06873-00095	UR Rock Salt 'White'										<0.5	0.020
06873-00096	UR Rock Salt 'Grey'										<0.5	<0.020
06873-00097	UR Coal										<0.5	<0.020

IS = International Standard SS = Sub-sample Dup = Field Duplicate WSol = Water Soluble

Appendix B.3 Soil CEC, TOC, pH, LOI and Colour Determinations

(CEC, TOC, pH, LOI and colour - BGS laboratories Keyworth)

LIMS ID	Sample Number	CEC meq/100g corrected for LOI @ 105°C	CEC meq/100g on prepared material not corrected for moisture	% TOC on prepared material not corrected for moisture	% Moisture @ 105°C on prepared material	pH	LOI @ 450°C	Munsell Code (Dry) (KCO)	Munsell Chart Colour	Munsell Code (Dry) (SM)	Munsell Chart Colour
06873-00001	UR1					7.9	2.4	2.5Y 5/2	greyish brown	5Y 5/2	reddish grey
06873-00002	UR4	9.2	8.7	0.82	5.2	8.0	2.6	10YR 6/2	light brownish grey	2.5Y 6/3	light yellowish brown
06873-00003	UR5					8.0	2.5	10YR 5/3	brown	2.5Y 5/2	greyish brown
06873-00004	UR6	12.7	11.8	1.02	7.4	8.2/8.2	3.7	2.5Y 5/2	greyish brown	2.5Y 5/2	greyish brown
06873-00005	UR7 Dup B3	9.7	9.6	0.96	0.9	8.1	2.9	10YR 5/4	yellowish brown	7.5YR 5/3	brown
06873-00006	UR8 SS B2					7.9	3.4	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00007	UR9					7.9	2.4	10YR 5/4	yellowish brown	10YR 5/3	brown
06873-00008	UR10					7.7/7.7	2.6	7.5YR 5/2	brown	10YR 5/2	greyish brown
06873-00009	UR11					7.8	2.1	2.5Y 6/3	light yellowish brown	2.5Y 6/1	grey
06873-00010	UR13	4.9	4.9	0.48	1.0	7.8	1.9	10YR 5/3	brown	10YR 6/2	light brownish grey
06873-00011	UR14	15.0	14.7	0.62	1.8	7.8	2.6	10YR 5/2	greyish brown	2.5Y 5/2	greyish brown
06873-00012	UR15					7.9	1.7	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00013	UR16					8.0	2.7	2.5Y 6/2	light olive grey	2.5Y 7/2	light grey
06873-00014	UR17	9.8	9.7	0.96	1.2	8.0/8.0	3.4	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00015	UR18	10.4	10.2	1.08	1.7	8.0	3.4	2.5Y 7/2	light grey	2.5Y 7/2	light grey
06873-00016	UR19 SS A2					7.7/7.8	3.5	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00017	UR20					7.8	2.7	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00018	UR21					7.9	2.6	2.5Y 6/3	light yellowish brown	5Y 6/2	light olive grey
06873-00019	UR22					8.1	1.8	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00020	UR23	8.3	8.2	0.82	0.6	7.9	2.6	2.5Y 7/3	pale yellow	2.5Y 7/2	light grey
06873-00021	UR23 (2)					7.9	2.5	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00022	UR24	22.1	21.3	0.72	3.5	8.0	3.3	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00023	UR25					8.4/8.4	3.1	2.5Y 6/3	light yellowish brown	2.5Y 7/2	light grey

LIMS ID	Sample Number	CEC meq/100g corrected for LOI @	CEC meq/100g on prepared	% TOC on prepared material not	% Moisture @ 105°C on	pH	LOI @ 450°C	Munsell Code (Dry)	Munsell Chart Colour	Munsell Code (Dry)	Munsell Chart Colour

LIMS ID	Sample Number	CEC meq/100g corrected for LOI @ 105°C	CEC meq/100g on prepared material not corrected for moisture	% TOC on prepared material not corrected for moisture	% Moisture @ 105°C on prepared material	pH	LOI @ 450°C	Munsell Code (Dry) (KCO)	Munsell Chart Colour	Munsell Code (Dry) (SM)	Munsell Chart Colour
06873-00024	UR26					8.0	2.1	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00025	UR27					7.8	2.7	2.5Y 6/2	light olive grey	10YR 6/1	grey
06873-00026	UR28 Dup A3	14.4	14.3	0.92	0.9	7.8	3.0	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00027	UR29					8.0	2.2	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00028	UR30 Dup B2					7.8	3.7	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00029	UR31					8.0	1.7	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00030	UR33					7.7/7.8	2.3	2.5Y 6/2	light olive grey	2.5Y 7/1	light grey
06873-00031	UR34 SS B1					7.9	2.8	2.5Y 6/3	light yellowish brown	5Y 6/2	light olive grey
06873-00032	UR35					9.4/9.4	1.0	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00033	UR36					8.2	3.0	2.5Y 7/2	light grey	2.5Y 7/2	light grey
06873-00034	UR37					8.2	2.5	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00035	UR38	5.6	5.5	0.66	0.8	8.1	2.3	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00036	UR39					7.9	2.3	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00037	UR40					8.0	2.5	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00038	UR41					8.0	2.3	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00039	UR42					8.3	3.0	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00040	UR43					8.3	0.7	2.5Y 6/2	light olive grey	5Y 6/2	light olive grey
06873-00041	UR44	18.2	17.9	0.71	1.9	8.1	2.5	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00042	UR45					8.0	1.6	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00043	UR46	5.6	5.5	0.50	0.9	7.9/7.9	2.1	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00044	UR47 IS GBW07402					8.6/8.7	3.0				
06873-00045	UR48	6.9	6.9	0.62	0.7	7.9	2.4	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00046	UR49					7.9	2.5	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00047	UR50					7.9	1.7	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00048	UR51 SS B3					8.0	2.9	10YR 5/4	yellowish brown	10YR 5/4	yellowish brown
06873-00049	UR52					8.2	0.5	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00050	UR53 SS A3					7.7	2.9	10YR 6/4	light yellowish brown	10YR 6/4	light yellowish brown

LIMS ID	Sample Number	CEC meq/100g corrected for LOI @ 105°C	CEC meq/100g on prepared material not corrected for moisture	% TOC on prepared material not corrected for moisture	% Moisture @ 105°C on prepared material	pH	LOI @ 450°C	Munsell Code (Dry) (KCO)	Munsell Chart Colour	Munsell Code (Dry) (SM)	Munsell Chart Colour
06873-00051	UR54 Dup A2					7.7/7.8	3.4	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00052	UR55					8.1	2.8	10YR 6/4	light yellowish brown	10YR 6/4	light yellowish brown
06873-00053	UR56					8.7/8.6	2.7	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00054	UR57	4.0	3.9	0.50	0.8	8.2	1.8	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00055	UR58					8.2	2.4	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00056	UR59	4.4	4.3	0.73	0.8	8.1	2.3	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00057	UR60 SS A1					7.9	3.1	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00058	UR61					8.1	2.6	2.5Y 7/3	pale yellow	2.5Y 6/3	light yellowish brown
06873-00059	UR62					7.9	1.8	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00060	UR64					8.3	2.2	2.5Y 7/3	pale yellow	2.5Y 7/3	pale yellow
06873-00061	UR65	9.1	8.9	0.68	1.7	8.2	2.6	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00062	UR66 Dup B1	13.7	13.5	0.78	1.6	7.8/7.9	3.0	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00063	UR67					7.9	1.9	10YR 6/4	light yellowish brown	10YR 6/4	light yellowish brown
06873-00064	UR69	4.9	4.8	0.62	0.8	7.9	2.2	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00065	UR70	5.0	5.0	0.54	0.7	7.9	2.2	10YR 6/4	light yellowish brown	10YR 6/3	light yellowish brown
06873-00066	UR71 Dup A1	14.9	14.7	0.75	1.7	7.9	2.8	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00067	UR72	9.7	9.6	0.96	0.9	8.1	2.8	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00068	UR73	7.5	7.4	1.00	0.9	8.0	3.3	2.5Y 7/2	light grey	2.5Y 6/3	light yellowish brown
06873-00069	UR74					8.2/8.1	2.6	2.5Y 7/3	pale yellow	2.5Y 6/3	light yellowish brown
06873-00070	UR75	14.9	14.6	1.42	2.6	8.1	4.2	10YR 6/2	light brownish grey	10YR 5/1	grey
06873-00071	UR76					8.1	2.8	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00072	UR77	3.4	3.4	0.47	0.4	8.0	1.7	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00073	UR78					8.0	2.6	10YR 7/3	very pale brown	10YR 6/3	pale brown
06873-00074	UR79	11.5	11.4	0.68	1.2	7.8	2.4	2.5Y 6/2	light olive grey	2.5Y 5/2	greyish brown
06873-00075	UR80					8.2	2.8	5Y 7/2	light grey	5Y 7/2	light grey
06873-00076	UR81					8.2/8.2	3.3	2.5Y 7/2	light grey	2.5Y 7/2	light grey
06873-00077	UR82	8.6	8.5	0.81	1.1	8.1	2.7	2.5Y 7/3	pale yellow	2.5Y 6/2	light olive grey

			moisture		material							
06873-00078	UR83						7.8	2.2	2.5Y 6/2	light olive grey	2.5Y 6/3	light yellowish brown
06873-00079	UR84						8.1	1.9	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00080	UR85						8.0	1.7	10YR 6/4	light yellowish brown	10YR 6/3	pale brown
06873-00081	UR86						8.3	0.6	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00082	UR87						7.9	2.5	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00083	UR88		5.3	5.2	0.62	0.8	8.1	1.5	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00084	UR89		7.3	7.1	0.41	1.7	8.1	1.6	2.5Y 6/3	light yellowish brown	2.5Y 6/3	light yellowish brown
06873-00085	UR90						8.1	1.9	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00086	UR92						8.2/8.2	2.5	2.5Y 7/2	light grey	2.5Y 7/2	light grey
06873-00087	UR93						7.9	2.2	2.5Y 6/3	light yellowish brown	2.5Y 6/2	light olive grey
06873-00088	UR94						8.1	1.8	2.5Y 7/2	light grey	2.5Y 7/2	light grey
06873-00089	UR95						8.7	1.5	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00090	UR96	IS GBW07402					8.7	3.0				
06873-00091	UR97						7.9	3.3	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00092	UR98						7.7/7.8	3.1	2.5Y 7/2	light grey	2.5Y 6/2	light olive grey
06873-00093	UR99		15.5	15.3	2.05	1.6	7.7	4.7	2.5Y 6/2	light olive grey	2.5Y 6/2	light olive grey
06873-00094	UR100						7.9	2.5	10YR 6/4	light yellowish brown	10YR 6/3	pale brown

Dup = Field Duplicate SS = Sub-sample IS = International Standard

APPENDIX C. LISTING OF WHEAT AND CABBAGE RESULTS

(I - EDI laboratories, Urumqi)

Sample No.	Village Name	Area Name	Longitude	Latitude	Wheat I µg/100g DW	Cabbage I µg/100g DW
1	Village 2	148	86.34332	44.81329	12.08	
4	Yimamu	Wushi	79.44896	41.25358	11.59	
5	Village 3	148	86.30249	44.85463	13.36	
6	Daqiao	Wushi	79.44982	41.20461	11.12	
7 Dup B3	Waqiao	Kuqa	82.95064	41.69511	12.88	10.35
8 SS B2	Wushi Town	Wushi	79.19675	41.20609	9.91	7.92
9	Wuzun	Kuqa	83.06312	41.67757	14.14	10.76
10	Village 6	148	86.30645	44.88418	12.16	11.04
11	Village 4	148	86.29101	44.87255	18.22	11.24/7.74
13	Village 21	148	86.29671	44.81384	14.27	
14	Village 4	148	86.29030	44.87348	12.4	8.2
15	Sandaqiao	Kuqa	82.76102	41.63218	17.75	
16	Autebeixi	Wushi	79.15801	41.17300	13.26	21.22
17	Wushi Town	Wushi	79.20022	41.20279	16.05	
18	Daqiao	Wushi	79.45909	41.22694	13.12	
19 SS A2	Wushi Town	Wushi	79.19675	41.20609	10.45	8.02
20	Village 6	148	86.30557	44.88440	14.06	15.53
21	Village 6	148	86.30277	44.88500	12.1	
22	Village 21	148	86.29474	44.81539	11.8	
23	Autebeixi	Wushi	79.15255	41.17687	11.14	10.66
24	Village 6	148	86.33062	44.87889	18.12	
25	Daqiao	Wushi	79.45084	41.21843	18.9	7.96
26	Yaha	Kuqa	83.28368	41.75003	16.29	23.46
27	Village 2	148	86.33967	44.81452	10.7	10.66
28 Dup A3	Waqiao	Kuqa	82.95064	41.69511	3.41	13.74
29	Qiman	Kuqa	82.92020	41.51246	11.87	7.17
30 Dup B2	Wushi Town	Wushi	79.19675	41.20609	10.2	8.65
31	Wuzun	Kuqa	83.05798	41.67846	5.89	17.86
33	Village 2	148	86.34333	44.82029	8.17	
34 SS B1	Village 2	148	86.33828	44.81547	5.17	10.12
36	Aheya	Wushi	79.66796	41.20408	12.16	
37	Village 3	148	86.29543	44.84878	10.59	tube exploded
38	Aheya	Wushi	79.67975	41.20124	11.31	11.75
39	Village 4	148	86.28722	44.87415	18.2	
40	Wuzun	Kuqa	83.05771	41.67667	11.13	
41	Autebeixi	Wushi	79.15717	41.17253	9.99	
42	Daqiao	Wushi	79.45208	41.21887	5.12	9.39
44	Village 6	148	86.30494	44.88451	22.01	16.19
45	Sandaqiao	Kuqa	82.76224	41.62607	9.49	10.88
46	Yaha	Kuqa	83.28301	41.75100	4.95	15.45
48	Yaha	Kuqa	83.27235	41.74760	29.18	

Sample No.	Village Name	Area Name	Longitude	Latitude	Wheat I µg/100g DW	Cabbage I µg/100g DW
49	Waqiao	Kuqa	82.96382	41.68739	3.17	8.64
50	Sandaqiao	Kuqa	82.76244	41.03225	6.14	6.63
51 SS B3	Waqiao	Kuqa	82.95064	41.69511	12.7	10.45
53 SS A3	Waqiao	Kuqa	82.95064	41.69511	3.14	14.16
54 Dup A2	Wushi Town	Wushi	79.19675	41.20609	10.54	8.08
55	Waqiao	Kuqa	82.95312	41.69402	7.16	
57	Sandaqiao	Kuqa	82.77062	41.61944	10.12	7.76
58	Qiman	Kuqa	82.92376	41.51496	38.87	
59	Qiman	Kuqa	82.92069	41.51225	27.43	3.55
60 SS A1	Village 2	148	86.33828	44.81547	7.12	11.74
61	Aheya	Wushi	79.67988	41.19744	17.17	7.17
62	Village 21	148	86.29687	44.81376	30.18	8.14
65	Aheya	Wushi	79.66699	41.20325	15.68	
66 Dup B1	Village 2	148	86.33828	44.81547	5.4	10.72
67	Yaha	Kuqa	83.27130	41.74716	13.65	
69	Wuzun	Kuqa	83.05751	41.67751	11.26	20.51
70	Wuzun	Kuqa	83.06312	41.67766	12.88	
71 Dup A1	Village 2	148	86.33828	44.81547	8.95	12.46
72	Yimamu	Wushi	79.44603	41.25198	16.71	
73	Wushi Town	Wushi	79.19227	41.20684	15.26	
74	Aheya	Wushi	79.67197	41.19485	36.25	9.35
75	Village 3	148	86.32156	44.84854	5.66	13.58
76	Autebeixi	Wushi	79.15899	41.17173	16.84	6.42
77	Sandaqiao	Kuqa	82.75656	41.63069	16.79	
78	Waqiao	Kuqa	82.95242	41.69412	23.56	
79	Village 4	148	86.29530	44.86791	28.94	
80	Yimamu	Wushi	79.45091	41.25699	22.61	20.98
81	Daqiao	Wushi	79.49645	41.22684	12.14	6.92
82	Autebeixi	Wushi	79.13145	41.18076	7.95	
83	Village 3	148	86.30329	44.85572	21.88	
84	Village 21	148	86.29526	44.81243	17.14	10.67
85	Yaha	Kuqa	83.28353	41.74937	16.71	9.42
87	Village 2	148	86.33876	44.81489	31.4	5.86
88	Qiman	Kuqa	82.93928	41.51042	13.22	9.47
89	Village 21	148	86.29688	44.81287	24.23	10.35
90	Qiman	Kuqa	82.93948	41.51140	6.43	
92	Yimamu	Wushi	79.45427	41.25730	11.24	8.42/9.13
93	Village 4	148	86.29101	44.83734	11.19	12.09
94	Yimamu	Wushi	79.45720	41.25583	12.11	17.69
97	Wushi Town	Wushi	79.19541	41.20452	23.09	7.57
98	Wushi Town	Wushi	79.19785	41.20496	5.81	14.19/15.32
99	Village 3	148	86.31927	44.84941	7.41	10.14
100	Waqiao	Kuqa	82.95005	41.69534	15.73	11.84

Dup = Field Duplicate SS = Sub-sample DW = dry weight

APPENDIX D. LISTING OF WATER RESULTS

Appendix D.1 Water Field Data

Sample No.	Area Name	Location	Longitude	Latitude	Source	Water Depth m	Comments
UR5	148	Village 3	86.30832	44.85051	Groundwater	60	Water collected from 148-school kitchen tap. Pumped to a tank and then piped to Village 3 and 148.
UR7 Dup B3	Kuqa	Waqiao	82.95090	41.69430	Groundwater	87	Water collected from tap in house. Piped to house.
UR22	148	Village 21	86.29214	44.87150	Groundwater	300	Water collected from tap in village centre. Pumped to a tower and piped to the village. At harvest time water is also taken from Village 22. The water is saline.
UR24	148	Village 6	86.30780	44.88380	Groundwater	200	Water collected from zinc tank in kitchen. Pumped to village at certain times of day.
UR28 Dup A3	Kuqa	Waqiao	82.95090	41.69430	Groundwater	87	Water collected from tap in house. Piped to house.
UR30 Dup B2	Wushi	Wushi Town	79.19675	41.20609	Groundwater	8	Water collected from pump outside house. Water light brown with moderate suspended solids.
UR31	Kuqa	Wuzun	83.05893	41.67759	Groundwater	60	Water collected from tap in house. Water pumped to village.
UR35	Wushi	River Tuoshigan	79.71754	41.21993	River	0	Water brown with high suspended solids.
UR38	Wushi	Aheya	79.67728	41.20032	Groundwater	60	Water collected from tap in house. Pumped to tower and piped to village. Water light brown with moderate suspended solids
UR42	Wushi	Daqiao	79.45022	41.21926	Groundwater	8	Water collected from pump outside house. Water light brown with minor suspended solids.
UR43	Wushi	River Tuoshigan	79.16931	41.24976	River	0	Water brown with moderate suspended solids
UR52	Wushi	River Tuoshigan	79.10217	41.20770	River	0	Water brown with moderate suspended solids
UR54 Dup A2	Wushi	Wushi Town	79.19675	41.20609	Groundwater	8	Water collected from pump outside house. Water light brown with moderate suspended solids.
UR56	Wushi	River Tuoshigan	79.46812	41.32035	River	0	Water is brown with high suspended solids
UR58	Kuqa	Qiman	82.92376	41.51496	Groundwater	80	Water from tap outside house. Pumped to a tower and piped to the village
UR64	Wushi	River Tuoshigan	78.98192	41.14431	River	0	Water brown with high suspended solids
UR66 Dup B1	148	Village 2	86.33967	44.81452	Groundwater	350	Water collected from tap in village shop. Pumped to a tower and piped to the village.
UR71 Dup A1	148	Village 2	86.33967	44.81452	Groundwater	350	Water collected from tap in village shop. Pumped to a tower and piped to the village.
UR77	Kuqa	Sandaqiao	82.75478	41.63053	Groundwater	13	Water collected from pump outside house. Water light brown with minor suspended solids.
UR79	148	Village 4	86.30157	44.86661	Groundwater	370	Water collected from metal storage drum in kitchen of house. Water is pumped to village at certain times of day.
UR80	Wushi	Yimamu	79.45080	41.25575	Groundwater	7	Water collected from pump outside house. Water light brown with moderate suspended solids.
UR82	Wushi	Autebeixi	79.13452	41.18071	Irrigation channel	0	Water collected from irrigation channel outside school 5 m downstream of school toilets, used as drinking water by 50% of village population. Water brown with moderate suspended solids.
UR85	Kuqa	Yaha	83.28560	41.75189	Spring	0	Water collected from tap in house. Water light brown with minor suspended solids
UR86	Wushi	River Tuoshigan	78.95720	41.11892	River	0	Water brown with high suspended solids
UR95	Wushi	River Tuoshigan	79.78012	41.17254	River	0	Water brown with high suspended solids

Dup = Field Duplicate

Appendix D.2. Water Chemical Parameter Determinations

(Ca, Mg, Na, K, SO4, NO2, NO3, Br, F - BGS laboratories Keyworth) (I - EDI laboratories Urumqi) (pH, Temp, Conductivity, Alkalinity, Eh - field determinations)

LIMS ID	Sample No	Water I µg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	Br mg/l	NO_2 mg/l	F mg/l	pH	Temp °C	Conductivity µS	Alkalinity mg/l $CaCO_3$	Field Eh mV	Corrected Eh mV
10035-0001	UR2 BW	1.5	3.67	0.031	<0.350	<0.500	0.22	<0.30	<0.30	<0.03	<0.01	<0.05	nd	nd	nd	nd	nd	nd
10035-0002	UR3 BW	1	0.296	0.027	0.425	<0.500	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10035-0003	UR5	93	3.14	0.457	115	<0.500	33.9	50.6	<0.30	<0.03	0.02	1.10	9.15	23.6	622	132	107.2	328
10035-0004	UR7 Dup B3	3.7	172	59.6	118	8.75	177	309	8.54	0.05	0.19	0.11	7.29	18.1	1840	288	56.3	282
10035-0005	UR22	100	45.0	113	1024	2.49	993	1150	<6.00	<0.60	0.72	1.12	8.50	25.6	5430	131	70.2	289
10035-0006	UR24	78	4.03	0.587	122	<0.500	44.1	59.4	<0.30	<0.03	0.03	1.13	8.80	23.4	580	121	108.1	329
10035-0007	UR28 Dup A3	4.4	175	61.0	121	8.91	164	291	16.5	0.06	<0.01	0.08	7.31	18.5	1820	282	51.9	277
10035-0008	UR30 Dup B2	1	80.0	34.0	30.4	4.09	32.5	71.9	11.7	<0.03	0.01	0.17	7.49	21.6	722	224	86	308
10035-0009	UR31	2.4	90.6	30.4	104	6.69	126	166	15.0	0.03	0.01	0.17	7.76	19.1	1083	168	56.6	282
10035-0010	UR32 BW	0.3	1.25	0.246	0.681	<0.500	1.18	2.24	<0.30	<0.03	<0.01	<0.05	nd	nd	nd	nd	nd	nd
10035-0011	UR35	1.8	76.5	52.3	64.4	5.42	67.1	132	5.27	<0.03	0.05	0.07	8.13	22.6	1014	255	60	281
10035-0012	UR38	0.1	109	53.8	96.8	7.97	69.3	258	13.5	<0.03	<0.01	0.51	7.68	24.1	1296	253	50	270
10035-0013	UR42	3.7	113	73.5	164	6.91	174	301	3.30	0.06	0.01	0.34	7.36	22.1	1840	180	67	289
10035-0014	UR43	0.1	46.6	22.4	17.9	2.29	23.3	66.4	5.16	<0.03	0.01	0.10	8.28	22.7	479	111	77.6	299
10035-0015	UR52	0.6	45.4	21.3	17.4	2.41	24.2	66.8	5.20	<0.03	0.02	0.13	8.33	21.8	476	115	54.5	277
10035-0016	UR54 Dup A2	0.9	78.6	33.1	28.3	4.44	31.7	70.7	11.3	<0.03	0.01	0.17	7.47	22.8	758	225	79.1	300
10035-0017	UR56	1.1	46.9	27.9	28.1	2.74	36.5	85.5	5.02	<0.03	0.01	0.15	8.36	21.7	561	128	72.5	295
10035-0018	UR58	3.20/2.99	38.2	23.2	48.7	6.41	64.8	84.5	0.70	<0.03	<0.01	0.76	7.88	21.4	625	81	63.7	286
10035-0019	UR64	0.65	47.5	21.4	20.0	2.33	44.7	69.3	2.35	<0.03	0.01	0.45	8.52	22.5	498	123	50	272
10035-0020	UR66 Dup B1	98/95	2.21	0.462	112	<0.500	32.6	50.6	<0.30	<0.03	<0.01	0.91	9.23	24.4	538	125	116.1	336
10035-0021	UR71 Dup A1	88	2.19	0.401	105	<0.500	33.0	50.5	<0.30	<0.03	<0.01	0.99	9.25	24.6	534	127	113.8	333
10035-0022	UR77	3.30/3.0	116	59.2	139	11.5	141	229	2.33	0.04	0.01	1.93	7.36	21.3	1690	332	44.4	267
10035-0023	UR79	80	4.58	0.700	127	<0.500	8.58	10.1	<0.30	<0.03	<0.01	0.24	9.02	24.4	565	129	116	336
10035-0024	UR80	2.1	95.8	58.3	43.9	6.41	61.8	112	5.00	<0.03	0.01	0.21	7.41	22.6	1080	315	55	276
10035-0025	UR82	0.4	54.0	22.7	20.6	2.70	31.7	68.6	4.85	<0.03	0.07	0.12	8.36	21.7	550	147	85	307
10035-0026	UR85	3.25	57.6	29.1	128	6.44	156	208	4.81	0.03	<0.01	0.32	8.00	19.8	1182	93	56.3	281
10035-0027	UR86	0.25	50.4	19.6	14.9	2.72	21.3	69.5	4.89	<0.03	0.01	0.11	8.06	22	510	113	60.5	283
10035-0028	UR95	1.2	79.6	41.9	56.7	4.59	55.9	169	4.64	<0.03	0.02	0.23	8.33	21.7	854	159	55	277

Dup = Field Duplicate BW = Blank Water Temp = Temperature nd = no data

APPENDIX E. LIST OF GEOCHEMICAL FIELD SAMPLING EQUIPMENT

Supplied by the BGS Geochemistry Group:

- aluminium carrying case
- portable pH/Eh meter - (HI 9024/ HI 9025) Hanna Instruments Water-resistant Microprocessor
- portable conductivity meter - (HI 933100) Hanna Instruments Portable Microprocessor Conductivity Meter
- spare AAA meter batteries
- Eh electrode - (Model 96-78-00) Orion Research Platinum Redox Electrode
- temperature probe
- pH electrode - Russel pH Limited Combination pH Electrodes
- pH buffer solutions 4.01, 7.01 and 10.01
- Orion AgCl electrode filling solution 90-00-01
- 30 NaOH pellets for iodine water samples
- conductivity standard 12.86 mS/cm
- Zobelles Eh calibration solution
- pH electrode storage solution
- deionised water wash bottle
- 50 30 ml Nalgene® bottles
- 5 250 ml polyethylene bicarbonate bottles
- 50 30 ml Steralin® tubes
- 4 plastic syringes
- 30 Millipore® 0.45µm disposable filter cartridges and 10 prefilters
- digital titrator - (Model 16900-01) Camlab Hach
- bromocresol indicator
- 2 0.16N and 2 1.6N H_2SO_4 Camlab titrator cartridges
- 250 ml plastic conical flask
- 1l plastic beaker
- 100 ml plastic measuring cylinder
- disposable pipettes
- Parafilm
- 1 roll laboratory towel
- box of tissues
- stainless steel trowel
- Large plastic sheet
- 200 grey 49x75 mm securitainers and white lids
- 100 large self-seal plastic bags
- 100 blank field cards
- random number list
- 3 black marker pens
- compass and hand lens
- Garmin 12 GPS

Supplied by the Bureau of Public Health, Xinjiang:

- Concentrated ARISTAR grade HNO_3
- De-ionised water
- Plastic bucket

Supplied by IRMA, Beijing

- Cloth vegetation sample bags

APPENDIX F. FIELD ANALYTICAL METHODS FOR WATER SAMPLES

pH and Temperature

(a) Remove the protective cap from the pH electrode and check that no air bubbles are trapped in the bulb at the end of the electrode. If air is present in the bulb, shake the electrode like a thermometer to remove the air. Connect the electrode and the temperature probe to the portable pH/Eh meter. Rinse the electrode and probe thoroughly with deionised water and dry them.

(b) Switch on the meter holding the on/off button for a few seconds until the LCD display appears.

(c) To calibrate the meter press the CAL button. The meter is now expecting the 4.01 calibration buffer solution. The first buffer solution measured during calibration is usually 7.01 therefore use the up arrow button to flick through the buffer solution options until 7.01 is selected. The meter is now ready to begin the calibration.

(d) Place the pH electrode and the temperature probe in the first buffer (7.01) and wait for the reading to stabilise. The meter initially indicates that the reading is NOT READY and will flash a READY signal when the reading has stabilised. Once the READY signal has appeared and the reading is stable press the CFM (confirm) button. Record the pH and temperature readings.

(e) The meter automatically expects the second buffer solution. Use the up and down arrow buttons to flick through the buffer solution options until the correct solution is selected (usually 4.01 for acid samples or 1.01 for alkaline samples). The meter is now ready to continue the calibration.

(f) Rinse the electrode and temperature probe thoroughly in deionised water and dry them. Place the electrode and probe in the second buffer solution and wait for the READY signal before pressing the CFM (confirm) button. Note the pH reading. The calibration is now complete and the meter automatically switches to pH measurement mode.

(g) To check the calibration, rinse the electrode and probe in deionised water, dry and return to the first buffer solution. The reading should stabilise around 7.01.

(h) Rinse the electrode and temperature probe thoroughly in deionised water and dry them before measuring the first sample. Rinse the electrode and probe with some of the sample water in-between measuring each sample.

(i) Store the pH electrode with the protective cap containing pH electrode storage solution over the end. Do not allow it to dry out. Care must be taken to avoid damage to the bulb at the end of the electrode.

(j) If the electrode performance is not satisfactory on calibration try shaking it to remove any air from the bulb.

Redox Potential

(a) Remove the protective cap from the redox (Eh) electrode and uncover the filling hole. Fill the electrode using Orion filling solution 90-00-11 to just below the filling hole. Empty the solution to waste by pushing the cap and body together and refill with solution ensuring that no bubbles are trapped around the electrode base. Connect the electrode and the temperature probe to the pH/Eh meter. Rinse the electrode and probe in deionised water and dry them.

(b) Switch on the meter holding the on/off button for a few seconds until the LCD display appears.

(c) Select the redox measurement function by pressing the RANGE button, mV will appear on the display.

(d) To check the electrode performance, place the electrode and probe in Zobelles solution. The value should settle between 200 and 250 mV, depending on the temperature.

(e) Rinse the electrode and temperature probe thoroughly in deionised water and dry them before measuring the first sample. Rinse the electrode and probe with some of the sample water in-between measuring each sample.

(f) The readings obtained require correction to redox potential relative to the standard hydrogen electrode according to the formula:

Corrected Eh = Measured Eh + (224 - Temperature°C)

(g) Prior to storage the electrode should be emptied and rinsed with deionised water. Store the electrode dry with the protective cap in place. A small amount of electrode storage solution should be added to the cap before storage.

Total Alkalinity

(a) Select a sulphuric acid cartridge 1.6N or 0.16N according to the expected alkalinity of the samples.

(b) Fit the cartridge to the hand held digital titrator and push the titrator piston down until it meets the top of the cartridge. Remove the cap from the cartridge and fit a feeder straw into the end of the cartridge. Wind the large wheel on the titrator until all the air is removed from the cartridge and the straw and a drop of acid leaves the end of the straw. Wipe the end of the straw to remove excess acid. Reset the titrator scale to zero by winding the small wheel to the left of the scale forwards.

(c) Rinse the measuring cylinder and conical flask with deionised water prior to rinsing them with a small amount of the first sample. Using the measuring cylinder, measure 100 ml of the first sample into the conical flask.

(d) Make sure the lid is securely tightened on the sample bottle in-between each stage of the measurements to reduce degassing of the samples.

(e) Add a few (two) drops of bromocresol green indicator using a small pipette.

(f) Add the acid using the large wheel on the titrator until the solution changes from blue to green-yellow and note the reading on the titrator scale when this occurs.

(g) When the 0.16N cartridge is used the readings should be multiplied by 0.1.

(h) The reading is the total alkalinity expressed as mg/l $CaCO_3$.

(i) The titrator should be reset to zero and the conical flask and measuring cylinder rinsed in a small amount of the next sample prior to the next measurement.

(j) Titrations should be carried out as quickly as possible to reduce degassing effects.

Conductivity

(a) Remove the plastic cover from the conductivity probe and rinse the probe and the cover in deionised water. Dry the probe and the cover and replace the cover. Connect the conductivity probe to the conductivity meter.

(b) Switch on the meter and place the probe in the 12.88 mS. calibration buffer solution making sure the solution covers the probe up to the join between the probe and the cover. The holes in the cover must be immersed in the solution.

(c) Shake the probe in the solution to remove any air bubbles trapped between the probe and the cover. This is important as the probe measures conductivity in the volume of <u>liquid</u> defined by the cover therefore <u>air</u> trapped in the cover will affect the readings.

(d) Press the CAL button and the 1413 µS indicator will be lit on the LCD display. Press the BUF button to change to the 12.88 mS calibration.

(e) When the reading is stable and the calibration is within +/- 15% of the ideal value the BUF indicator on the display stops flashing and the CON indicator appears on the display. When the CON indicator appears press the CFM (confirm) button. The meter is now calibrated and will automatically return to measurement mode. To quit from calibration mode at any time press the CAL button.

(f) Remove the plastic cover from the probe, rinse with deionised water and dry the probe and the cover prior to measuring each sample. Remember to cover the probe with sample up to the join between the cover and the probe and to remove air by shaking the probe.

(g) The probe and cover should be rinsed in deionised water and dried before storage.

(h) If the meter is difficult to calibrate try shaking the probe to remove air trapped under the cover.

APPENDIX G. BGS ANALYTICAL METHODS

Iodine Generation Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

The method was adapted from the work of (Cave and Green, 1989) and (Nakahara and Mori, 1994). The following standards were prepared for calibration: 0, 1, 5, 10, 25 and 50 ng/g I in deionised water from a stock KI solution. Standards and samples were prepared by the addition of 2 ml of 1% (w/v) ascorbic acid to 20 ml of standard/sample. The oxidation solution to convert I^- to I_2 was 0.2 g of $NaNO_2$ dissolved in 200 ml of 50% (v/v) H_2SO_4. The soil samples were fused and dissolved according to (Fuge et al., 1978). For the determination of water-soluble iodine, 1.5 +/- 0.05 g of prepared soil material were weighed accurately into 15 ml glass screw cap bottles and 15 ml of deionised water added. Samples were shaken on an end-over-end stirrer overnight then decanted into centrifuge tubes and centrifuged at 13 500 rpm for 3 minutes prior to analysis.

Iodine was determined by I_2 generation ICP-AES.

The instrument conditions were as follows

Varian Vista ICP-AES
Power 1.2 kW
Coolant Ar flow 18 l/min
Intermediate Ar flow 1.5 l/min
Injector flow 0.7 l min
Time resolved collection mode – 100 s data collection time with 1000 ms per data point.
Iodine wavelength 178.215 nm.

Iodine Generator

The generator consists of a glass bulb gas liquid separator (GLS) of about 30ml in volume. The injector gas to the ICP flows through the GLS. On the gas inlet side to the GLS an Omnifit injection valve with a 2.5 ml injection loop is connected, allowing the sample to be injected into the GLS using the injector gas flow to flush the sample from the sample loop into the GLS chamber. The GLS is also fitted with a liquid input line to allow the oxidation reagent to be injected into the chamber and, at the base of the GLS, a ground glass tap is used to drain off the exhausted solution after the iodine has been generated from the sample. The gas inlet to the GLS bubbles Ar directly into the sample/oxidation solution.

The GLS is operated in the following mode:

1. Load the injection valve with the sample
2. Drain the spent solution from the GLS
3. Inject 5ml of fresh oxidisation solution into the GLS
4. Inject the sample into the GLS with the valve and simultaneously start data collection

Results

The iodine generated from the GLS is swept into the ICP where I emission is detected. Typical signals are shown in Figure F.1. The area under the curve after the initial pressure pulse is used to calibrate the method (Figure F.2).

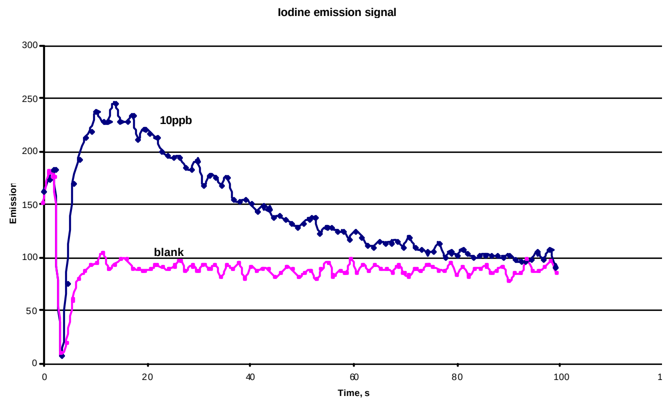


Figure F.1 Example iodine emission signal

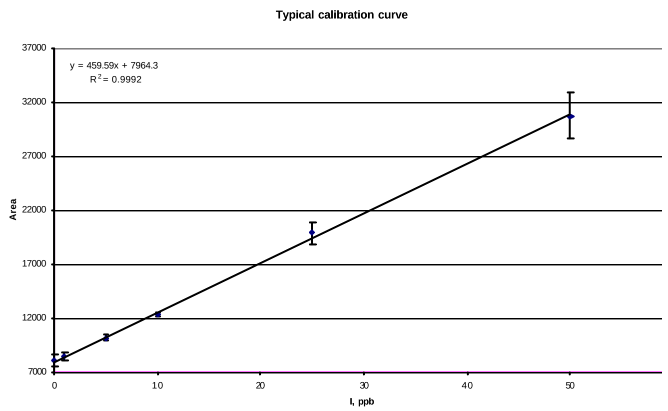


Figure F.2 Typical iodine calibration curve

For the Xinjiang soil samples, duplicate digestions and soil reference materials were analysed in the same analytical runs as the samples. The results for the reference materials are shown in Table F.1 and demonstrate that there was a bias at the lower concentration but at the higher concentration the accuracy was good.

The results for analytical duplicate digestions are given in Table F.2. Analysis of variance (ANOVA) of the data show that whilst there are significant differences between the samples, the 'within batch' variation in the digestion duplicates is insignificant (Table F.3).

The detection limit with pure standards is about 1ng/g in solution, which is equivalent to 0.2 µg/g in the soil sample. However, there was quite a large blank from the sample fusions that degrades the detection limit to about 0.5 µg/g in the soil and probably contributes to the lack of accuracy at the lower concentrations. Figure F. 3 shows an illustration of the digestion blank.

TABLE F.1 TOTAL IODINE CONCENTRATIONS (µg/g) DETERMINED IN SOIL REFERENCE MATERIALS

Date	GBW07401	Date	GBW07505
50701	1.59	300601	4.40
300601	1.80	290601	3.86
290601	1.32	280601	3.88
280601	1.71	270601	3.69
270601	1.75	260601	3.65
260601	1.59	200301	3.53
200301	1.23	260301	3.83
200301	1.34		
200301	1.67		
200301	1.87		
Average	1.59	Average	3.83
SD	0.22	SD	0.28
Reference value	1.9		3.8

TABLE F.2 ANALYTICAL REPLICATE RESULTS FOR SOIL TOTAL IODINE

Date	Sample No	Analytical Replicates I µg/g	
300601	87	1.052774	1.192572
290601	77	0.577435	0.656904
280601	70	0.910013	1.33249
270601	61	1.963961	1.222329
260601	55	0.825034	1.177099
220601	5	1.397821	0.994646
130301	13	0.500851	0.249351
200301	22	0.874856	0.963781
200301	29	1.274271	1.407438
260301	39	0.586687	0.691438
260301	44	1.543531	1.30418

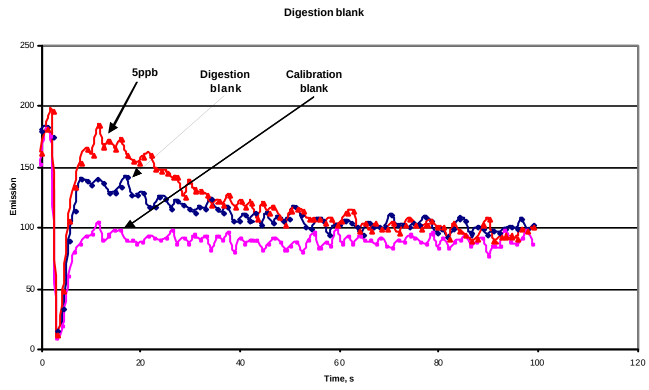


Figure F.3 Example of the soil iodine analysis digestion blank

TABLE F.3 ANOVA TWO-FACTOR WITHOUT REPLICATION OF SOIL TOTAL IODINE ANALYTICAL REPLICATE RESULTS

Summary	Count	Sum	Average	Variance
Row 1	2	2.245346	1.122673	0.009772
Row 2	2	1.234338	0.617169	0.003158
Row 3	2	2.242503	1.121252	0.089244
Row 4	2	3.18629	1.593145	0.275009
Row 5	2	2.002133	1.001066	0.061975
Row 6	2	2.392467	1.196234	0.081275
Row 7	2	0.750201	0.375101	0.031626
Row 8	2	1.838638	0.919319	0.003954
Row 9	2	2.681709	1.340855	0.008867
Row 10	2	1.278125	0.639062	0.005486
Row 11	2	2.84771	1.423855	0.028644
Column 1	11	11.50723	1.046112	0.209044
Column 2	11	11.19223	1.017475	0.126134

Source of Variation	SS	df	MS	F	P-value	F-crit
Samples	2.757281	10	0.275728	4.637989	0.011727	2.97824
Duplicates	0.00451	1	0.00451	0.07587	0.788582	4.964591
Error	0.594499	10	0.05945			
Total	3.35629	21				

APPENDIX H. LISTING OF MEDICAL RESULTS

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
1001	U/S	AC 148	AC 148	01-Apr-93	7.5	f	123.0	0.94	26.0	0.39	0.7	0.9	0.5	0.7	0.7	0.9						
1002	Blood & U/S	AC 148	AC 148	24-Feb-92	8.6	m	123.0	0.93	25.5	0.62	1.0	0.9	0.8	0.8	0.9	0.8	1.5	28.6	1.95	275	1.95	275
1003	Blood & U/S	AC 148	AC 148	27-Feb-93	7.6	m	125.0	0.96	26.4	1.72	1.1	1.2	1.2	1.4	1.2	1.2	2.9	47.5	2.90	1060	2.90	1060
1004	U/S	AC 148	AC 148	10-Jan-94	6.7	m	121.0	0.87	22.6	0.34	0.9	0.6	1.1	0.9	0.5	0.4						
1005	U/S	AC 148	AC 148	13-Mar-92	8.5	m	127.0	0.97	26.7	0.43	0.9	0.9	0.9	0.6	0.7	0.6						
1006	Blood & U/S	AC 148	AC 148	01-Jun-91	9.3	m	138.0	1.29	45.1	0.58	0.8	0.7	1.0	0.6	1.0	1.0	1.8	55.9	2.15/2.15	1112	2.15	1112
1007	Blood & U/S	AC 148	AC 148	18-Mar-93	7.5	f	121.5	0.87	22.2	0.27	0.6	0.8	0.7	0.8	0.6	0.5	2.2	53.9	2.90	720	2.90	720
1008	U/S	AC 148	AC 148	18-Jan-93	7.7	m	120.5	0.88	22.9	0.57	0.9	0.8	0.8	1.2	0.6	0.8						
1009	Blood & U/S	AC 148	AC 148	31-May-93	7.3	m	119.0	0.84	21.3	0.22	0.5	0.4	0.6	0.9	0.7	0.7	1.3	61.1	0.42	50	0.42	50
1010	Blood & U/S	AC 148	AC 148	08-Dec-91	8.8	f	134.0	0.99	25.5	0.78	1.1	1.3	0.9	0.9	0.7	0.8	1.6	52.0	1.20	425	1.20	425
1011	U/S	AC 148	AC 148	23-Feb-93	7.6	f	120.5	0.87	22.3	0.36	0.8	0.8	0.5	0.5	1.0	0.9						
1012	Blood & U/S	AC 148	AC 148	29-Mar-92	8.5	f	130.5	1.03	29.5	0.30	0.8	0.7	0.8	0.9	0.5	0.5	1.2	50.1	0.45	195	0.45	195
1013	Blood & U/S	AC 148	AC 148	12-Aug-91	9.1	f	130.5	1.00	27.0	0.41	0.8	0.7	0.8	0.8	0.8	0.6	3.1	41.6	1.65/1.55	610	1.60	610
1014	Blood & U/S	AC 148	AC 148	06-Dec-90	9.8	m	135.5	1.05	28.8	0.28	0.8	0.6	0.6	0.4	0.8	0.8	1.7	48.1	3.30	460	3.30	460
1015	U/S	AC 148	AC 148	18-Nov-92	7.9	f	120.0	0.86	22.0	0.94	1.1	1.2	0.7	0.9	1.0	1.1						
1016	Blood & U/S	AC 148	AC 148	15-Dec-91	8.8	f	131.1	1.00	27.0	1.15	1.6	1.1	1.0	0.8	0.9	1.1	0.3	33.2	0.52	168	0.52	168
1017	U/S	AC 148	AC 148	06-Mar-92	8.6	m	127.0	0.96	25.7	0.52	0.9	0.9	0.7	0.8	0.7	0.9						
1018	Blood & U/S	AC 148	AC 148	03-Jun-91	9.3	m	128.5	1.00	27.7	0.49	0.9	1.0	0.7	0.5	0.9	0.9	0.3	44.9	3.10	720	3.10	720
1019	Blood & U/S	AC 148	AC 148	14-Apr-93	7.5	m	125.0	0.93	24.8	0.20	0.7	0.8	0.7	0.9	0.4	0.3	0.9	48.8	1.35	325	1.35	325
1020	Blood & U/S	AC 148	AC 148	30-Apr-92	8.4	f	135.5	1.07	30.0	0.16	0.8	0.6	0.6	0.4	0.4	0.6	0.2	39.7	1.85	318	1.85	318
1021	Blood & U/S	AC 148	AC 148	12-Apr-92	8.5	f	125.0	0.85	20.0	0.25	0.4	0.7	0.6	0.8	0.8	0.6	0.8	42.3	1.30	215	1.30	215
1022	Blood & U/S	AC 148	AC 148	05-Apr-90	10.5	m	130.0	1.06	31.5	0.68	1.1	0.7	0.9	1.0	0.8	0.9	2.8	65.7	1.55	445	1.55	445
1023	Blood & U/S	AC 148	AC 148	11-Apr-92	8.5	f	134.0	1.04	28.6	0.47	0.8	0.8	0.7	0.9	0.6	0.9	2.8	51.4	5.20	460	5.20	460
1024	Blood & U/S	AC 148	AC 148	12-Apr-91	9.5	f	131.0	0.93	22.6	1.07	1.1	1.0	1.1	0.9	1.1	1.0	2.1	41.0	1.70	450	1.70	450
1025	Blood & U/S	AC 148	AC 148	08-Feb-92	8.6	m	125.5	0.92	24.0	0.67	1.3	1.0	0.6	0.5	1.1	1.1	4.7	49.4	0.87	295	0.87	295

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
1026	Blood & U/S	AC 148	AC 148	24-Mar-94	6.5	m	119.5	0.86	22.0	0.12	0.8	0.8	0.8	0.4	0.3	0.2	1.5	52.7	0.42	95	0.42	95
1027	Blood & U/S	AC 148	AC 148	20-Mar-92	8.5	f	121.5	0.94	26.5	0.31	0.5	0.6	0.7	0.8	0.6	0.9	3.0	52.7	1.60	680	1.60	680
1028	Blood & U/S	AC 148	AC 148	05-Aug-93	7.1	f	122.0	0.90	23.7	0.59	1.0	1.0	0.6	0.7	0.9	1.0	2.2	52.0	0.74	630	0.74	630
1029	Blood & U/S	AC 148	AC 148	03-Nov-91	8.9	f	128.0	0.91	22.5	0.45	0.6	0.8	0.7	0.7	0.9	1.0	2.6	58.5	0.21	460	0.21	460
1030	Blood & U/S	AC 148	AC 148	21-Jul-93	7.2	m	122.0	0.85	20.7	0.82	1.2	0.8	1.0	0.8	1.0	0.8	2.8	34.5	1.80	470	1.80	470
1031	Blood & U/S	AC 148	AC 148	15-Sep-92	8.0	m	124.5	0.92	24.4	0.62	0.5	0.8	1.1	1.1	0.9	0.9	2.4	nd	1.10	830	1.10	830
1032	Blood & U/S	AC 148	AC 148	07-Apr-92	8.5	m	126.5	0.95	25.7	0.86	0.9	0.9	1.0	1.1	0.9	1.0	2.2	19.5	1.05	nd	1.05	nd
1033	Blood & U/S	AC 148	AC 148	27-Dec-91	8.8	m	130.0	1.00	27.6	0.36	0.8	0.7	0.5	0.5	1.0	1.0	1.0	46.8	0.91	205	0.91	205
1034	Blood & U/S	AC 148	AC 148	07-Dec-93	6.8	m	117.5	0.86	22.6	0.41	0.9	0.8	0.8	0.9	0.5	0.7	1.4	35.8	0.03	485	0.03	485
1035	Blood & U/S	AC 148	AC 148	15-May-91	9.4	m	126.5	0.95	25.4	0.44	1.0	1.1	0.8	0.8	0.6	0.5	1.8	37.1	3.10	600	3.10	600
1036	Blood & U/S	AC 148	AC 148	19-Feb-89	11.6	m	136.0	1.11	32.5	1.19	1.0	0.9	1.6	0.9	1.0	1.1	1.1	46.2	4.4/4.4	520	4.40	520
1037	Blood & U/S	AC 148	AC 148	10-Apr-92	8.5	m	122.5	0.91	24.0	0.60	0.7	0.7	0.9	1.0	1.1	0.8	3.0	48.8	0.29	305	0.29	305
1038	Blood & U/S	AC 148	AC 148	09-Aug-89	11.1	m	132.5	1.02	28.0	0.59	1.0	0.9	1.1	0.8	0.6	0.8	2.0	33.8	1.05	300	1.05	300
1039	Blood & U/S	AC 148	AC 148	16-Jul-92	8.2	f	124.5	0.96	26.6	0.56	0.6	0.7	1.1	1.1	0.6	1.0	1.0	61.1	1.85	460	1.85	460
1040	Sample leaked	AC 148	AC 148	12-Jul-93	7.2	m	137.0	1.14	34.0	0.31	0.6	0.5	1.0	0.9	0.7	0.5	3.8	41.6				
1042	Blood & U/S	AC 148	AC 148	27-Aug-92	8.1	m	125.3	0.98	27.5	0.56	0.9	0.7	0.7	1.2	0.8	0.8	2.2	52.7	0.67	600	0.67	600
1043	Blood & U/S	AC 148	AC 148	25-Jan-92	8.7	m	129.5	1.07	32.0	0.52	0.7	0.8	0.9	0.8	0.8	0.9	2.7	35.1	2.50	460	2.50	460
1044	Blood & U/S	AC 148	AC 148	21-May-91	9.4	m	132.0	0.99	26.2	0.32	0.6	0.5	1.0	0.9	0.6	0.7	1.2	48.1	2.30	930	2.30	930
1045	Blood & U/S	AC 148	AC 148	22-Apr-94	6.4	f	118.5	0.84	21.5	0.28	0.8	1.0	0.8	0.8	0.3	0.5	1.5	48.8	1.00	340	1.00	340
1046	Blood & U/S	AC 148	AC 148	23-May-94	6.3	f	123.5	0.90	23.5	0.33	1.3	0.9	1.1	1.5	0.3	0.2	0.6	34.5	0.78	70/68	0.78	69
1047	Blood & U/S	AC 148	AC 148	12-Nov-92	7.9	f	122.5	0.87	22.0	0.57	0.8	0.8	1.0	1.0	0.8	0.7	0.8	28.6	2.55/2.6	260	2.58	260
1048	Blood & U/S	AC 148	AC 148	18-Mar-94	6.5	f	121.0	0.87	22.6	0.23	0.8	1.0	0.9	0.9	0.3	0.3	0.3	40.3	1.30	335	1.30	335
1049	Blood & U/S	AC 148	AC 148	03-Dec-93	6.8	m	120.5	0.86	21.7	0.27	0.7	0.6	0.8	0.6	0.7	0.5	2.5	64.4	1.15	510	1.15	510
1050	Blood & U/S	AC 148	AC 148	04-Aug-92	8.1	f	137.0	1.14	34.2	0.37	0.7	0.8	1.0	0.6	0.7	0.6	0.5	31.9	3.60	163	3.60	163
1051	U/S	AC 148	AC 148	05-Sep-92	8.1	m	120.0	0.88	23.1	0.44	1.0	0.6	0.6	0.9	0.9	0.7						
1052	U/S	AC 148	AC 148	05-Oct-92	8.0	f	120.0	0.88	23.0	0.31	0.7	0.8	0.6	0.6	0.5	0.9						
1053	U/S	AC 148	AC 148	05-Aug-92	8.1	m	123.5	0.91	23.8	0.52	0.7	0.8	0.7	1.0	0.9	0.8						
1054	U/S	AC 148	AC 148	19-Oct-93	6.9	f	122.5	0.88	22.5	0.35	0.8	0.8	0.6	1.1	0.6	0.5						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
1055	U/S	AC 148	AC 148	28-Mar-93	7.5	f	123.0	0.93	25.4	0.57	1.0	0.9	1.1	1.2	0.5	0.6						
1056	U/S	AC 148	AC 148	12-Jul-93	7.2	f	118.0	0.82	20.0	0.34	0.8	0.7	0.6	0.6	0.6	1.0						
1057	U/S	AC 148	AC 148	18-Feb-92	8.6	m	123.0	0.90	23.8	0.78	0.9	0.8	1.1	0.9	1.0	0.9						
1058	U/S	AC 148	AC 148	12-Nov-93	6.9	f	113.0	0.79	20.0	0.34	0.8	0.6	0.8	0.8	0.6	0.7						
1059	U/S	AC 148	AC 148	13-May-94	6.4	f	120.5	0.86	22.0	0.48	0.8	0.5	0.9	0.9	0.9	0.8						
1060	U/S	AC 148	AC 148	21-May-92	8.4	f	124.5	0.89	22.5	0.33	1.0	0.7	0.7	0.8	0.5	0.6						
1061	U/S	AC 148	AC 148	16-Jul-92	8.2	f	119.0	0.85	21.9	0.54	0.8	0.9	1.1	0.8	0.7	0.7						
1062	U/S	AC 148	AC 148	23-Jul-92	8.2	m	134.5	1.23	42.2	0.56	0.7	1.0	0.8	0.8	0.8	0.9						
1063	U/S	AC 148	AC 148	15-Feb-93	7.6	m	121.0	0.89	23.7	0.65	1.0	1.0	0.9	0.8	0.7	0.9						
1064	U/S	AC 148	AC 148	16-Feb-93	7.6	f	116.0	0.80	19.5	0.53	0.5	0.8	0.9	0.8	1.2	0.9						
1065	U/S	AC 148	AC 148	10-Jan-94	6.7	m	123.5	0.89	23.0	0.93	1.0	1.2	1.2	1.3	0.7	0.7						
1066	U/S	AC 148	AC 148	27-Nov-92	7.8	f	119.0	0.90	25.1	1.23	1.2	1.1	0.7	0.8	1.7	1.3						
1067	U/S	AC 148	AC 148	12-Aug-92	8.1	f	113.0	0.81	21.0	0.73	1.2	1.2	0.5	0.8	1.1	0.9						
1068	U/S	AC 148	AC 148	15-Nov-90	9.9	m	138.0	1.13	33.2	1.16	1.3	1.3	0.9	1.2	1.0	0.8						
1069	U/S	AC 148	AC 148	01-Jan-93	7.7	f	122.5	0.87	22.0	0.66	0.9	0.8	0.9	0.9	0.9	0.9						
1070	U/S	AC 148	AC 148	14-Apr-93	7.5	f	123.0	0.92	25.0	0.54	0.6	0.8	0.9	1.0	0.9	0.8						
1071	U/S	AC 148	AC 148	27-Feb-93	7.6	f	120.0	0.86	22.3	0.79	0.9	0.8	1.2	1.1	0.8	0.9						
1072	U/S	AC 148	AC 148	10-Jan-94	6.7	f	110.0	0.75	18.7	0.21	0.7	0.7	0.8	0.8	0.3	0.5						
1073	U/S	AC 148	AC 148	12-Mar-89	11.5	m	146.0	1.34	45.1	1.83	1.1	1.1	1.4	1.5	1.3	1.1						
1074	U/S	AC 148	AC 148	19-Nov-93	6.9	f	116.5	0.78	18.5	0.34	0.6	0.5	1.0	1.2	0.6	0.6						
1075	U/S	AC 148	AC 148	21-Oct-92	7.9	m	123.0	0.90	23.5	0.27	1.0	0.8	0.5	0.8	0.5	0.5						
1076	U/S	AC 148	AC 148	21-Mar-92	8.5	f	118.5	0.87	23.2	0.46	0.9	0.8	0.8	0.6	0.8	0.8						
1077	U/S	AC 148	AC 148	17-Mar-93	7.5	m	124.5	0.89	22.4	0.68	0.7	0.6	0.9	1.1	1.1	1.1						
1078	U/S	AC 148	AC 148	15-Jul-92	8.2	f	127.0	0.99	28.0	0.77	0.7	1.1	1.1	1.1	1.0	0.7						
1079	U/S	AC 148	AC 148	27-Feb-92	8.6	m	126.0	0.95	25.5	0.22	0.7	0.5	0.5	0.7	0.7	0.6						
1080	U/S	AC 148	AC 148	07-Jun-94	6.3	m	115.5	0.81	20.5	0.48	0.9	1.0	0.5	0.6	0.9	1.0						
1081	U/S	AC 148	AC 148	03-Jul-93	7.2	m	116.5	0.77	18.0	0.31	0.5	0.7	0.7	0.7	1.0	0.6						
1082	U/S	AC 148	AC 148	17-May-93	7.4	f	123.0	0.87	21.8	0.52	1.0	0.9	1.2	0.8	0.6	0.5						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
1083	U/S	AC 148	AC 148	16-Jun-93	7.3	m	126.0	1.01	29.4	0.25	0.7	0.8	0.8	0.9	0.4	0.4						
1084	U/S	AC 148	AC 148	13-Mar-94	6.5	m	126.0	0.87	21.0	0.79	1.1	1.0	0.6	0.9	1.0	1.1						
1085	U/S	AC 148	AC 148	08-Dec-92	7.8	m	126.0	0.95	25.3	0.51	0.9	1.0	0.8	0.7	0.8	0.7						
1086	U/S	AC 148	AC 148	12-May-93	7.4	f	120.0	0.83	20.3	0.54	1.1	1.1	0.6	0.6	1.0	0.7						
1087	U/S	AC 148	AC 148	20-Oct-90	9.9	m	137.0	1.08	30.0	0.65	1.1	1.0	0.7	0.9	0.6	1.0						
1088	U/S	AC 148	AC 148	21-Apr-94	6.4	f	120.0	0.83	20.0	0.10	0.7	0.3	0.6	1.0	0.3	0.3						
1089	U/S	AC 148	AC 148	14-Dec-93	6.8	m	120.0	0.91	25.3	0.25	0.9	0.5	0.7	1.1	0.4	0.5						
1090	U/S	AC 148	AC 148	13-Jun-93	7.3	f	123.5	0.90	23.6	0.38	0.5	0.5	0.8	0.7	1.0	1.1						
1091	U/S	AC 148	AC 148	03-Dec-92	7.8	m	129.0	1.00	27.7	0.49	1.1	0.8	0.7	0.7	0.9	0.6						
1092	U/S	AC 148	AC 148	24-Mar-93	7.5	m	122.0	0.91	24.3	0.53	1.0	0.7	1.0	1.2	0.6	0.6						
1093	U/S	AC 148	AC 148	03-Feb-93	7.6	f	118.5	0.82	20.0	0.18	0.8	0.7	0.6	0.5	0.5	0.4						
1094	U/S	AC 148	AC 148	20-Jan-91	9.7	f	133.0	1.08	31.7	1.04	0.8	0.8	0.9	1.4	1.3	1.1						
1095	U/S	AC 148	AC 148	05-Nov-93	6.9	f	117.5	0.79	18.7	0.46	0.9	1.1	0.7	0.7	0.9	0.5						
1096	U/S	AC 148	AC 148	20-Nov-92	7.9	m	127.0	0.91	22.9	0.41	0.9	0.6	0.8	1.0	0.6	0.7						
1097	U/S	AC 148	AC 148	26-Dec-91	8.8	f	124.0	0.96	27.3	0.59	0.7	0.6	0.6	1.1	1.2	1.1						
1098	U/S	AC 148	AC 148	28-Jun-94	6.2	f	108.5	0.77	20.0	0.22	0.8	0.6	0.7	0.8	0.4	0.5						
1099	U/S	AC 148	AC 148	26-Jun-94	6.3	m	127.5	0.95	25.1	0.19	0.6	0.8	0.7	1.1	0.3	0.3						
1100	U/S	AC 148	AC 148	19-Apr-92	8.4	m	130.0	0.94	23.6	0.24	0.5	0.6	0.7	1.0	0.6	0.5						
1101	Blood & U/S	AC 148	AC 148	20-Jul-92	8.2	m	124.7	0.93	24.7	0.47	0.7	0.7	0.7	0.7	0.9	1.1	0.5	28.6	0.11	620	0.11	620
1102	U/S	AC 148	AC 148	18-Jan-92	8.7	f	111.0	0.78	19.7	0.55	0.8	0.7	0.8	0.9	0.9	0.9						
1103	Blood & U/S	AC 148	AC 148	18-Mar-89	11.5	f	135.0	1.03	27.3	0.46	1.1	0.9	0.6	0.8	0.7	0.7	0.6	53.9	2.10	660	2.10	660
1104	Blood & U/S	AC 148	AC 148	10-Jul-92	8.2	m	133.5	1.11	33.2	0.84	1.0	1.2	1.1	0.7	0.9	0.9	2.2	19.5	2.10	830	2.10	830
1105	Blood & U/S	AC 148	AC 148	10-May-93	7.4	f	128.0	0.94	24.4	0.97	0.7	1.1	1.1	0.9	1.1	1.2	1.2	39.7	0.93	230	0.93	230
1106	U/S	AC 148	AC 148	01-Jan-93	7.7	f	117.0	0.82	20.8	0.58	0.9	0.8	0.8	1.0	0.8	0.8						
1108	Blood & U/S	AC 148	AC 148	02-Jun-93	7.3	f	127.0	0.99	28.0	0.56	0.8	0.9	0.8	0.9	0.8	0.8	1.7	53.3	1.55	340	1.55	340
1111	Blood & U/S	AC 148	AC 148	15-Jan-93	7.7	f	126.0	0.95	25.3	0.49	0.8	0.9	1.1	0.9	0.6	0.6	2.1	38.4	3.60	740	3.60	740
1115	Blood & U/S	AC 148	AC 148	12-Apr-93	7.5	f	130.0	1.01	28.0	0.31	0.7	0.8	0.6	0.9	0.7	0.5	2.4	49.4	2.90	598/600	2.90	599
1117	Blood & U/S	AC 148	AC 148	05-Jan-93	7.7	m	118.5	0.77	17.5	0.26	0.6	0.6	0.6	0.7	0.7	0.7	2.1	53.3	2.60	468	2.60	468

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
1121	U/S	AC 148	AC 148	02-Mar-93	7.6	m	132.5	1.08	32.0	0.54	1.1	0.7	0.6	1.1	0.9	0.7						
1125	U/S	AC 148	AC 148	28-May-93	7.3	m	121.0	0.86	21.7	0.29	0.5	0.5	1.1	0.9	0.7	0.5						
1138	U/S	AC 148	AC 148	13-May-93	7.4	m	112.0	0.78	19.4	0.66	0.8	0.7	0.8	1.2	1.1	0.8						
1141	U/S	AC 148	AC 148	15-Apr-91	9.5	f	130.0	0.95	24.4	0.74	1.0	0.8	0.9	1.0	1.1	0.7						
1146	U/S	AC 148	AC 148	14-Feb-91	9.6	m	125.0	0.98	28.0	0.34	0.6	0.3	1.0	1.0	0.9	0.6						
1168	U/S	AC 148	AC 148	20-Sep-93	7.0	f	129.0	0.95	24.5	0.31	0.6	0.6	0.6	1.1	0.7	0.6						
1171	Blood & U/S	AC 148	AC 148	23-Jul-91	9.2	f	142.0	1.18	35.0	0.68	1.0	1.0	0.8	0.9	1.0	0.7	2.8	68.9	2.50	355	2.50	355
1173	U/S	AC 148	AC 148	13-Dec-93	6.8	m	123.5	0.87	21.8	0.37	0.8	0.6	0.6	0.9	0.7	0.8						
1176	Blood & U/S	AC 148	AC 148	27-Jun-91	9.3	f	134.0	1.02	27.2	0.58	0.9	0.5	0.8	1.1	1.0	0.9	1.3	47.5	4.40	340	4.40	340
1185	U/S	AC 148	AC 148	10-Jun-93	7.3	f	124.0	0.94	25.8	0.62	1.0	0.8	0.9	0.9	0.8	0.8						
2001	Blood & U/S	Wushi	Aheya	08-May-89	11.5	m	140.0	1.08	29.0	1.38	1.3	1.0	1.3	1.2	1.0	1.0	0.6	34.5	4.80	350	4.80	350
2002	U/S	Wushi	Daqiao	15-May-90	10.5	m	139.2	1.10	30.5	1.34	1.3	0.9	1.1	0.8	1.3	1.3						
2003	U/S	Wushi	Daqiao	06-Aug-87	13.2	m	143.0	1.16	33.0	0.60	0.7	0.7	0.9	0.9	1.0	1.0						
2004	U/S	Wushi	Aheya	05-Oct-88	12.1	m	147.0	1.14	30.5	0.77	1.2	1.0	0.9	0.9	0.9	0.7						
2005	U/S	Wushi	Aheya	01-May-89	11.5	m	140.0	0.96	22.0	0.81	0.9	0.9	0.9	1.2	0.9	0.9						
2006	U/S	Wushi	Aheya	13-Mar-92	8.6	m	126.0	0.96	26.0	0.92	1.3	0.9	1.0	1.1	0.8	0.9						
2007	U/S	Wushi	Daqiao	01-Feb-92	8.8	m	130.0	0.96	25.0	0.89	1.2	1.1	1.1	1.2	0.8	0.6						
2008	U/S	Wushi	Daqiao	04-Oct-91	9.1	f	142.5	1.00	23.5	0.79	0.8	0.7	1.2	1.1	1.0	0.9						
2009	U/S	Wushi	Daqiao	05-Jun-91	9.4	f	131.5	0.97	25.0	1.19	1.2	0.9	1.2	1.0	1.1	1.0						
2010	U/S	Wushi	Aheya	23-Mar-91	9.6	m	132.0	1.00	27.0	0.79	0.9	0.9	1.1	1.2	0.9	0.7						
2011	Blood & U/S	Wushi	Aheya	04-Nov-91	9.0	f	136.5	1.00	25.0	0.71	0.7	0.6	1.0	1.2	1.0	1.1	1.1	50.7	1.10	322	1.10	322
2012	U/S	Wushi	Daqiao	10-Mar-91	9.6	m	129.0	0.99	27.0	0.60	0.9	1.0	0.7	0.7	1.0	0.9						
2013	U/S	Wushi	Aheya	12-Apr-90	10.6	f	121.7	0.89	23.5	0.66	1.2	1.1	0.8	0.8	0.8	0.7						
2014	U/S	Wushi	Aheya	05-Jul-92	8.3	f	130.8	0.89	20.5	1.24	1.3	1.0	1.1	1.3	0.9	1.0						
2015	U/S	Wushi	Daqiao	01-Sep-91	9.2	f	130.5	0.95	24.0	0.79	1.0	1.0	0.8	0.7	1.1	1.1						
2016	U/S	Wushi	Aheya	29-Aug-90	10.2	f	135.7	1.06	29.0	1.15	1.0	0.9	1.1	1.2	1.2	1.0						
2017	U/S	Wushi	Aheya	04-Aug-92	8.2	f	121.0	0.86	22.0	0.95	0.9	0.9	0.9	1.1	1.1	1.1						
2018	U/S	Wushi	Aheya	15-Jun-92	8.4	f	121.2	0.88	23.0	1.02	0.9	1.0	1.2	1.4	0.8	0.9						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
2020	U/S	Wushi	Aheya	25-Mar-90	10.6	m	128.5	0.89	21.5	0.28	0.7	0.6	0.9	0.9	0.5	0.5						
2021	Blood & U/S	Wushi	Aheya	29-Sep-91	9.1	f	122.5	0.83	19.5	1.38	1.1	1.1	1.1	1.0	1.2	1.3	2.3	29.9	1.35	440	1.35	440
2022	U/S	Wushi	Aheya	15-Dec-90	9.9	m	127.0	0.89	21.5	0.73	1.0	1.0	0.9	0.9	0.8	0.9						
2023	U/S	Wushi	Aheya	05-Dec-90	9.9	f	131.0	0.94	23.5	0.50	0.7	0.7	0.8	1.1	0.9	0.7						
2024	U/S	Wushi	Aheya	23-Jul-90	10.3	m	137.8	1.03	26.5	0.72	0.9	1.0	1.1	0.8	0.8	0.9						
2025	Blood & U/S	Wushi	Aheya	22-Aug-90	10.2	m	137.5	0.92	20.5	2.19	1.4	1.2	1.3	1.2	1.4	1.4	2.2	37.1	0.42	415	0.42	415
2026	U/S	Wushi	Daqiao	03-Mar-90	10.7	f	125.8	0.94	25.0	1.04	1.0	0.8	1.0	1.1	1.2	1.1						
2027	U/S	Wushi	Aheya	08-Feb-91	9.7	f	135.5	0.93	21.5	0.72	1.1	1.1	0.7	0.6	1.1	1.0						
2028	U/S	Wushi	Daqiao	15-Jun-91	9.4	f	120.5	0.82	19.5	0.73	1.4	1.1	0.4	0.6	1.3	1.2						
2029	U/S	Wushi	Aheya	24-Apr-90	10.5	m	136.5	1.14	34.0	0.98	1.0	1.0	1.2	1.2	0.9	0.8						
2031	U/S	Wushi	Daqiao	04-Apr-90	10.6	m	135.5	1.05	28.5	1.31	1.0	0.9	1.4	1.2	1.1	1.1						
2032	U/S	Wushi	Daqiao	02-Sep-92	8.2	m	130.7	0.93	23.0	0.69	0.8	1.2	0.8	0.8	0.9	0.9						
2033	U/S	Wushi	Aheya	10-Oct-92	8.1	f	125.0	0.85	20.1	0.39	1.0	0.6	0.8	0.9	0.6	0.6						
2034	Blood & U/S	Wushi	Daqiao	01-Apr-91	9.6	m	125.0	0.89	22.0	0.54	0.9	1.0	0.9	0.8	0.7	0.7	0.6	35.8	1.25	810/814	1.25	812
2035	U/S	Wushi	Aheya	23-Oct-87	13.0	m	153.0	1.01	21.0	0.80	0.9	0.7	0.9	1.0	1.1	1.1						
2036	U/S	Wushi	Aheya	29-Jan-88	12.8	m	140.0	1.09	29.5	0.46	0.8	0.8	0.9	0.8	0.8	0.6						
2037	U/S	Wushi	Aheya	01-Apr-89	11.6	m	150.0	1.22	34.0	0.60	1.3	0.9	0.4	1.1	0.9	0.8						
2038	Blood & U/S	Wushi	Aheya	18-Feb-91	9.7	m	135.0	1.08	30.5	1.57	1.2	1.1	1.7	1.2	0.9	1.1	1.0	43.6	1.15	470	1.15	470
2039	U/S	Wushi	Aheya	10-Jan-93	7.8	f	124.5	0.89	22.5	0.26	0.6	0.6	0.7	1.0	0.6	0.5						
2040	U/S	Wushi	Daqiao	10-Apr-91	9.6	m	129.5	0.96	25.0	1.18	1.4	0.9	0.9	1.0	1.1	1.2						
2041	Blood & U/S	Wushi	Aheya	18-May-90	10.5	m	139.0	0.92	20.0	1.36	1.0	0.9	1.5	1.1	1.1	1.2	0.2	24.7	0.36	383	0.36	383
2042	U/S	Wushi	Aheya	07-Feb-92	8.7	f	121.0	0.90	24.0	0.72	0.9	0.8	0.8	1.0	1.1	0.9						
2043	U/S	Wushi	Aheya	02-Apr-91	9.6	f	128.8	0.92	23.0	1.35	0.9	0.9	1.4	1.3	1.3	1.0						
2044	U/S	Wushi	Aheya	10-Nov-90	10.0	m	133.0	1.09	32.5	0.97	0.8	0.9	1.2	1.3	0.9	1.0						
2045	U/S	Wushi	Daqiao	15-Jun-90	10.4	m	142.5	1.19	35.0	0.89	0.9	1.1	0.9	0.9	1.2	0.9						
2046	Blood & U/S	Wushi	Daqiao	01-Apr-91	9.6	m	130.0	0.94	23.5	0.49	0.9	0.8	0.6	1.1	0.6	0.8	0.2	53.3	0.61	450	0.61	450
2047	Blood & U/S	Wushi	Daqiao	02-May-91	9.5	m	125.0	0.89	22.0	0.68	1.1	0.9	0.8	0.7	0.9	1.0	1.1	37.7	0.12	365	0.12	365
2048	U/S	Wushi	Daqiao	03-Jan-90	10.8	m	122.0	0.84	20.0	0.41	0.6	0.6	1.3	1.1	0.5	0.7						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
2049	U/S	Wushi	Daqiao	15-Mar-91	9.6	f	123.8	0.88	22.0	0.66	1.1	1.0	0.8	0.7	1.0	0.7						
2050	Blood & U/S	Wushi	Daqiao	15-Jul-91	9.3	m	126.5	0.94	25.0	0.60	0.8	1.1	0.8	0.8	1.0	0.7	2.5	32.5	1.20	334	1.20	334
2051	U/S	Wushi	Daqiao	10-Jul-91	9.3	f	124.5	0.90	23.0	0.61	0.8	0.9	0.7	0.9	1.1	0.8						
2052	U/S	Wushi	Aheya	29-Jan-91	9.8	f	128.8	0.87	20.0	1.08	1.1	0.9	1.1	0.9	1.2	1.0						
2053	U/S	Wushi	Daqiao	10-Apr-90	10.6	f	127.0	0.93	24.0	0.95	1.0	0.9	1.2	1.0	0.9	1.0						
2054	U/S	Wushi	Daqiao	08-Jul-91	9.3	f	123.0	0.77	16.5	0.53	0.9	0.7	0.6	0.8	1.0	1.0						
2055	U/S	Wushi	Daqiao	15-Jun-91	9.4	m	125.2	0.90	23.0	1.15	1.2	1.2	1.1	0.9	1.0	1.0						
2056	U/S	Wushi	Aheya	05-Mar-92	8.7	f	121.5	0.84	20.5	0.32	1.0	0.6	0.5	1.0	0.6	0.6						
2057	U/S	Wushi	Daqiao	02-Oct-90	10.1	f	134.5	1.04	28.5	1.63	1.4	1.1	1.2	1.3	1.0	1.2						
2059	U/S	Wushi	Aheya	12-Oct-89	11.1	m	135.5	1.09	31.5	0.75	1.1	1.1	0.7	0.8	0.9	1.0						
2060	U/S	Wushi	Daqiao	05-Apr-91	9.6	f	122.5	0.86	21.0	0.64	1.1	0.9	0.7	0.8	0.8	1.0						
2061	U/S	Wushi	Aheya	01-Nov-88	12.0	m	151.5	1.34	42.0	0.89	1.1	0.9	0.8	1.1	1.1	0.9						
2062	U/S	Wushi	Aheya	05-Jun-92	8.4	f	130.8	0.88	20.0	0.72	1.1	1.1	0.8	0.8	0.9	0.8						
2064	Blood & U/S	Wushi	Aheya	15-Sep-91	9.1	f	135.5	0.90	20.0	0.75	0.8	0.7	0.9	1.1	1.1	1.0	2.0	33.1	0.96/1.05	275	1.01	275
2065	U/S	Wushi	Aheya	26-Dec-88	11.9	m	137.5	1.07	29.0	0.46	0.8	0.7	0.9	0.9	0.8	0.6						
2066	U/S	Wushi	Daqiao	04-May-91	9.5	f	126.5	0.91	23.0	1.04	1.1	1.0	1.1	1.1	0.8	1.1						
2067	U/S	Wushi	Daqiao	15-Aug-91	9.2	m	125.0	0.93	25.0	0.53	1.1	1.1	0.6	0.5	1.0	0.8						
2068	Blood & U/S	Wushi	Daqiao	01-Feb-91	9.8	f	123.5	0.85	20.5	0.39	0.6	0.6	0.7	1.1	0.7	0.8	2.2	33.2	0.78	393/403	0.78	398
2069	U/S	Wushi	Daqiao	15-Aug-91	9.2	m	126.5	0.94	25.0	1.42	1.1	1.3	1.2	0.9	1.0	1.4						
2070	Blood & U/S	Wushi	Daqiao	18-Jan-92	8.8	m	135.0	1.06	29.5	0.74	0.9	0.8	1.4	1.2	0.7	0.7	0.6	28.6	0.66	38/40	0.66	39
2071	U/S	Wushi	Daqiao	02-Aug-90	10.3	f	141.5	1.06	27.0	1.29	1.4	1.1	1.1	1.0	1.1	0.9						
2072	U/S	Wushi	Aheya	04-Oct-90	10.1	m	130.0	0.93	23.0	0.74	1.2	0.8	0.9	0.9	0.9	0.8						
2073	Blood & U/S	Wushi	Aheya	28-Jan-89	11.8	m	141.5	0.94	20.3	1.58	1.2	1.2	1.3	1.1	1.1	1.2	1.7	39.0	0.49	100	0.49	100
2074	U/S	Wushi	Aheya	10-Sep-88	12.1	m	147.0	1.21	34.5	0.76	1.0	0.9	1.0	1.1	0.9	0.7						
2075	U/S	Wushi	Aheya	12-Apr-92	8.6	f	124.0	0.85	20.5	0.38	0.8	0.5	0.9	0.7	0.8	0.6						
2076	Blood & U/S	Wushi	Aheya	15-Jul-92	8.3	f	131.5	0.92	22.2	0.49	0.8	0.7	0.9	0.9	0.8	0.7	0.8	27.9	2.40	1032	2.40	1032
2077	U/S	Wushi	Aheya	23-Jun-92	8.4	m	119.5	0.89	24.0	0.73	1.1	0.8	0.9	1.0	0.9	0.8						
2078	U/S	Wushi	Daqiao	16-Sep-90	10.1	m	126.0	0.92	23.5	0.64	0.9	0.7	1.0	1.1	0.8	0.8						

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2079	U/S	Wushi	Aheya	15-Aug-90	10.2	f	139.5	0.94	21.0	1.04	1.3	1.0	0.9	1.0	1.0	1.0						
2080	U/S	Wushi	Aheya	17-Nov-91	9.0	m	123.0	0.88	22.0	0.59	1.1	1.0	0.7	1.0	0.7	0.7						
2081	U/S	Wushi	Aheya	03-Jun-92	8.4	m	115.2	0.77	18.0	0.22	0.5	0.7	0.7	0.5	0.8	0.5						
2082	Blood & U/S	Wushi	Aheya	05-Jul-92	8.3	f	141.2	0.93	20.0	0.89	1.0	1.0	0.8	1.0	1.2	0.9	2.4	40.9	0.48	293	0.48	293
2083	U/S	Wushi	Aheya	15-Mar-91	9.6	m	136.5	1.06	29.0	1.12	1.0	1.0	1.3	1.3	0.8	1.0						
2084	U/S	Wushi	Aheya	30-Dec-92	7.8	f	120.0	0.86	22.0	0.29	0.6	0.5	0.6	0.9	0.8	0.7						
2085	Blood & U/S	Wushi	Daqiao	03-Dec-89	10.9	m	126.5	0.98	27.5	0.59	1.5	1.1	0.6	0.6	0.7	0.9	0.5	35.8	0.18	20	0.18	20
2086	U/S	Wushi	Aheya	14-Feb-91	9.7	m	128.5	0.87	20.0	0.87	1.3	1.0	0.7	1.1	0.9	0.9						
2087	U/S	Wushi	Aheya	11-Jan-90	10.8	f	135.6	0.92	21.0	0.97	1.0	1.1	1.2	1.2	0.8	0.8						
2088	U/S	Wushi	Aheya	03-May-90	10.5	m	134.0	1.05	29.0	0.72	1.0	0.8	1.1	0.8	0.9	0.8						
2089	U/S	Wushi	Aheya	29-May-88	12.4	f	136.5	1.03	27.0	1.03	1.0	0.9	1.4	1.1	0.9	0.9						
2090	U/S	Wushi	Aheya	18-Feb-89	11.7	m	143.5	1.17	33.5	0.62	0.9	0.9	1.0	0.9	0.9	0.6						
2091	U/S	Wushi	Daqiao	15-Jul-90	10.3	m	128.0	0.93	24.0	0.68	0.9	1.1	1.2	1.0	0.6	0.7						
2092	U/S	Wushi	Aheya	03-Apr-92	8.6	m	127.0	0.90	22.0	1.02	1.0	0.8	1.4	1.4	0.8	0.9						
2093	U/S	Wushi	Aheya	23-Mar-92	8.6	f	121.5	0.87	22.0	1.10	1.1	1.1	1.0	1.2	1.0	0.9						
2094	U/S	Wushi	Aheya	17-May-92	8.5	f	121.0	0.84	20.5	0.25	0.5	0.4	0.8	0.9	0.7	0.7						
2095	U/S	Wushi	Aheya	15-Aug-89	11.2	m	138.0	1.13	33.0	1.15	1.1	0.8	1.4	1.2	1.0	0.9						
2096	U/S	Wushi	Daqiao	05-Jun-91	9.4	f	144.0	1.07	27.0	0.98	1.4	1.0	0.8	0.8	0.9	1.3						
2097	U/S	Wushi	Aheya	05-May-92	8.5	m	123.3	0.89	23.0	0.50	1.0	0.9	0.8	0.9	0.7	0.6						
2098	U/S	Wushi	Aheya	27-Aug-90	10.2	f	135.0	1.05	28.5	1.26	1.1	0.9	1.2	1.2	1.1	1.1						
2099	U/S	Wushi	Aheya	18-Apr-92	8.5	f	133.0	0.97	24.5	0.69	1.1	0.8	0.8	1.0	0.9	0.8						
2100	U/S	Wushi	Daqiao	15-Mar-91	9.6	m	126.5	0.86	20.0	0.46	0.9	0.7	0.9	0.8	0.7	0.7						
2101	U/S	Wushi	Daqiao	07-Feb-87	13.7	m	154.0	1.29	37.5	3.36	1.5	1.4	1.7	1.6	1.7	1.2						
2102	U/S	Wushi	Autebeixi	07-Dec-89	10.9	f	139.0	1.03	26.0	0.77	1.0	0.9	0.8	1.2	0.8	0.9						
2103	U/S	Wushi	Wushi Town	07-May-91	9.5	f	133.0	1.01	27.0	1.15	1.0	1.0	1.3	1.0	1.0	1.1						
2104	Blood & U/S	Wushi	Wushi Town	05-Aug-92	8.2	m	130.0	0.90	21.5	1.03	1.1	1.2	0.9	0.8	1.1	1.1	2.1	34.5	1.00	460	1.00	460
2105	U/S	Wushi	Wushi Town	02-Mar-92	8.7	m	139.0	1.19	37.0	0.69	1.1	1.0	1.1	0.6	0.7	1.0						
2106	U/S	Wushi	Wushi Town	06-Dec-91	8.9	m	130.0	0.98	26.0	0.43	0.7	0.7	0.8	0.8	0.8	0.8						

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2107	U/S	Wushi	Wushi Town	04-Jul-92	8.3	m	128.0	0.90	22.0	0.85	0.9	1.1	0.8	0.9	1.1	1.0						
2108	U/S	Wushi	Wushi Town	05-Nov-91	9.0	m	129.0	0.97	26.0	0.69	1.0	0.9	0.8	0.9	0.9	0.9						
2109	U/S	Wushi	Wushi Town	03-Apr-91	9.6	f	130.0	0.96	25.0	1.79	1.5	1.1	1.3	1.0	1.3	1.1						
2110	U/S	Wushi	Wushi Town	01-Aug-98	2.2	f	128.0	0.92	23.0	0.71	1.4	1.0	0.4	0.7	1.4	1.0						
2111	U/S	Wushi	Daqiao	02-Aug-88	12.3	m	145.0	1.22	36.0	1.01	1.1	1.2	1.0	0.6	1.2	1.1						
2112	U/S	Wushi	Wushi Town	10-Jun-91	9.4	f	126.0	0.97	27.0	1.57	1.2	1.3	0.9	0.8	1.3	1.8						
2113	U/S	Wushi	Wushi Town	01-Feb-91	9.8	f	135.0	1.02	27.0	1.31	0.9	1.2	1.2	1.2	1.2	1.0						
2114	U/S	Wushi	Autebeixi	15-Jul-90	10.3	f	128.5	0.99	27.0	1.81	1.5	1.3	1.1	1.1	0.9	1.6						
2115	U/S	Wushi	Wushi Town	16-Apr-91	9.5	m	138.0	1.07	29.0	2.63	1.3	1.2	2.0	1.6	1.3	1.1						
2116	U/S	Wushi	Wushi Town	01-May-90	10.5	m	127.0	0.98	27.0	0.74	1.1	0.8	0.9	0.9	0.9	0.9						
2117	U/S	Wushi	Wushi Town	02-Aug-91	9.3	f	128.0	0.97	26.0	0.65	1.0	1.0	1.0	0.7	0.8	0.8						
2118	Blood & U/S	Wushi	Wushi Town	01-Jul-92	8.3	f	125.0	0.93	25.0	0.73	0.9	0.8	0.9	1.0	1.0	0.9	4.0	62.4	1.95	260	1.95	260
2119	Blood & U/S	Wushi	Wushi Town	03-Jan-92	8.8	m	125.0	0.89	22.5	0.71	0.8	0.6	1.0	0.6	1.3	1.2	1.8	43.6	0.21	25	0.21	25
2120	U/S	Wushi	Autebeixi	03-Oct-89	11.1	f	127.0	0.84	19.0	0.59	0.7	0.8	0.9	1.0	0.8	0.9						
2121	U/S	Wushi	Daqiao	02-Apr-87	13.6	m	147.6	1.20	34.0	2.19	1.3	1.4	1.3	1.3	1.3	1.3						
2122	Blood & U/S	Wushi	Daqiao	02-Jun-91	9.4	f	130.2	1.00	27.5	0.57	1.0	1.0	0.6	0.7	0.8	1.0	3.8	42.9	0.40	238	0.40	238
2123	U/S	Wushi	Wushi Town	01-Jul-92	8.3	f	125.0	0.90	23.0	1.14	1.1	1.3	1.1	1.0	0.9	1.0						
2124	Blood & U/S	Wushi	Wushi Town	21-Mar-92	8.6	f	131.0	0.97	25.0	0.93	0.8	0.9	1.1	1.2	1.1	0.9	0.2	66.9	1.25	293	1.25	293
2125	U/S	Wushi	Daqiao	25-Feb-87	13.7	m	148.2	1.24	36.5	1.25	1.3	1.2	0.9	1.0	1.1	1.1						
2126	U/S	Wushi	Autebeixi	07-May-90	10.5	f	130.0	0.95	24.5	1.07	1.0	0.9	1.1	0.9	1.3	1.0						
2127	U/S	Wushi	Wushi Town	01-Nov-91	9.0	m	131.0	1.00	27.0	0.80	1.1	0.9	0.7	1.2	0.9	0.9						
2128	U/S	Wushi	Autebeixi	19-Sep-90	10.1	f	142.0	0.97	22.0	1.08	1.0	1.0	1.1	0.9	0.9	1.4						
2129	U/S	Wushi	Wushi Town	03-Nov-89	11.0	m	143.0	1.14	32.0	1.23	0.9	1.1	1.1	1.2	1.0	1.2						
2130	U/S	Wushi	Wushi Town	17-Feb-91	9.7	m	122.0	0.89	23.0	0.49	0.8	0.8	0.8	0.8	0.8	0.8						
2131	Blood & U/S	Wushi	Autebeixi	25-Jan-89	11.8	f	126.0	0.96	26.0	2.24	1.2	1.2	1.3	1.4	1.7	1.2	1.1	35.1	0.26	358	0.26	358
2132	U/S	Wushi	Wushi Town	01-Aug-92	8.3	m	130.0	0.95	24.0	0.49	0.8	0.8	0.9	0.7	0.8	0.8						
2133	U/S	Wushi	Autebeixi	12-Jun-89	11.4	f	134.0	0.93	22.0	0.62	1.0	0.8	0.8	0.9	0.8	0.9						
2134	U/S	Wushi	Daqiao	01-May-88	12.5	f	147.6	1.15	30.5	1.18	0.8	1.1	0.9	1.0	1.6	1.2						

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2135	U/S	Wushi	Wushi Town	05-Feb-93	7.7	f	125.0	0.89	22.0	0.51	0.9	0.9	1.0	0.7	0.7	0.7						
2136	U/S	Wushi	Wushi Town	01-May-91	9.5	m	133.0	0.98	25.0	1.96	0.4	0.8	4.2	4.3	0.8	0.8						
2138	U/S	Wushi	Daqiao	25-Sep-86	14.1	m	148.2	1.11	28.0	1.86	1.2	1.2	1.2	1.5	1.2	1.2						
2139	U/S	Wushi	Daqiao	19-Apr-89	11.5	f	145.5	1.17	33.0	0.81	1.1	1.0	0.9	1.0	0.9	0.8						
2140	U/S	Wushi	Wushi Town	03-Nov-91	9.0	f	130.0	0.96	25.0	0.82	1.0	1.0	0.9	1.0	0.9	0.9						
2141	U/S	Wushi	Daqiao	01-Feb-87	13.8	m	148.5	1.12	28.5	1.77	1.1	1.4	1.2	1.1	1.4	1.2						
2142	U/S	Wushi	Wushi Town	01-Jun-91	9.4	f	129.0	0.92	23.0	0.73	0.9	1.0	0.9	1.0	0.9	0.8						
2143	U/S	Wushi	Autebeixi	06-Feb-91	9.7	f	137.7	1.05	28.0	1.02	1.1	0.9	1.1	1.1	1.1	0.8						
2144	U/S	Wushi	Wushi Town	21-Dec-91	8.9	m	116.0	0.85	23.0	0.75	0.8	0.9	1.2	0.7	1.1	0.8						
2145	U/S	Wushi	Wushi Town	04-May-91	9.5	f	127.0	0.93	24.0	0.58	0.8	0.7	1.1	0.9	0.8	0.8						
2146	Blood & U/S	Wushi	Daqiao	01-Oct-91	9.1	f	115.5	0.83	21.5	0.48	1.0	0.8	0.7	0.8	0.8	0.7	0.2	50.7	3.10	113	3.10	113
2147	U/S	Wushi	Daqiao	16-Mar-89	11.6	f	146.5	1.22	36.0	0.89	1.2	1.2	0.9	0.8	1.0	0.8						
2148	U/S	Wushi	Daqiao	15-Sep-88	12.1	f	151.0	1.32	41.0	1.49	1.4	1.3	1.0	0.9	1.3	1.1						
2149	U/S	Wushi	Wushi Town	01-Feb-92	8.8	m	130.0	0.99	27.0	1.25	1.8	1.0	0.9	1.0	1.0	1.0						
2150	U/S	Wushi	Wushi Town	01-Mar-92	8.7	m	132.0	1.00	27.0	0.36	0.7	0.6	0.9	0.8	0.6	0.8						
2151	U/S	Wushi	Wushi Town	01-Oct-89	11.1	m	130.0	0.95	24.0	0.78	0.9	0.9	0.9	0.9	1.0	1.0						
2152	U/S	Wushi	Wushi Town	03-Sep-90	10.2	m	135.0	1.02	27.0	1.07	1.1	0.8	1.1	1.1	1.2	0.9						
2153	Blood & U/S	Wushi	Autebeixi	11-May-89	11.5	f	133.5	1.01	27.0	1.20	1.1	1.1	1.2	1.2	1.0	0.9	0.5	54.6	0.19	730	0.19	730
2154	U/S	Wushi	Daqiao	03-Jun-87	13.4	f	138.9	1.09	30.0	0.65	1.0	0.7	0.6	1.0	1.2	0.9						
2155	U/S	Wushi	Autebeixi	08-May-89	11.5	f	125.0	0.89	22.5	1.00	1.1	0.9	1.1	1.1	0.9	1.0						
2156	U/S	Wushi	Wushi Town	01-Aug-89	11.3	m	130.0	0.98	26.0	1.47	1.1	1.2	1.1	1.2	1.1	1.2						
2157	U/S	Wushi	Wushi Town	01-Oct-91	9.1	m	133.0	1.01	27.0	0.69	0.9	0.8	0.9	1.1	0.9	0.8						
2158	U/S	Wushi	Autebeixi	09-Sep-89	11.1	f	131.5	0.96	24.5	1.87	1.1	1.2	1.3	1.3	1.2	1.4						
2159	U/S	Wushi	Wushi Town	01-Aug-92	8.3	f	130.0	0.98	26.0	0.60	1.0	0.9	0.9	0.5	1.0	0.8						
2160	U/S	Wushi	Wushi Town	18-Sep-92	8.1	f	115.0	0.82	21.0	0.51	0.8	0.6	0.8	0.8	0.9	1.0						
2161	U/S	Wushi	Autebeixi	17-Jan-93	7.8	m	127.0	0.95	25.0	0.77	0.9	1.0	0.6	0.8	1.2	1.2						
2162	Blood & U/S	Wushi	Autebeixi	14-Dec-89	10.9	f	134.7	1.07	30.5	1.03	0.8	0.9	0.9	1.3	1.2	1.1	0.5	41.6	0.44/0.42	43	0.43	43
2163	U/S	Wushi	Wushi Town	28-Oct-92	8.0	f	118.0	0.82	20.0	0.48	1.0	0.8	0.6	0.9	0.7	0.8						

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2164	U/S	Wushi	Daqiao	05-Jun-87	13.4	m	135.0	1.02	27.0	0.83	0.9	0.8	1.1	0.9	1.1	0.9						
2165	U/S	Wushi	Wushi Town	25-Sep-91	9.1	m	128.0	0.95	25.0	0.59	0.6	0.7	0.9	1.2	0.9	0.9						
2166	U/S	Wushi	Wushi Town	01-Sep-91	9.2	m	122.0	0.89	23.0	1.14	1.1	1.1	1.2	1.2	1.0	0.8						
2167	U/S	Wushi	Wushi Town	23-Jun-92	8.4	f	122.0	0.85	21.0	0.64	0.9	1.0	0.7	0.7	1.0	1.0						
2168	U/S	Wushi	Daqiao	03-Jun-90	10.4	m	135.0	0.96	23.5	1.03	1.2	1.1	1.0	1.4	0.9	0.7						
2169	U/S	Wushi	Wushi Town	01-Mar-91	9.7	f	132.0	1.00	27.0	0.72	0.8	0.9	1.0	1.1	0.9	0.8						
2170	U/S	Wushi	Daqiao	01-Apr-89	11.6	f	145.0	1.13	30.5	1.22	1.2	1.2	0.9	1.2	0.9	1.1						
2171	U/S	Wushi	Daqiao	06-Apr-89	11.6	m	140.8	1.10	30.0	1.05	1.0	1.0	1.1	1.0	1.0	1.1						
2172	U/S	Wushi	Wushi Town	04-Aug-91	9.2	f	122.0	0.87	22.0	0.99	0.9	1.2	0.9	0.8	1.0	1.3						
2173	Blood & U/S	Wushi	Daqiao	06-May-91	9.5	f	117.5	0.86	23.0	0.46	0.5	0.7	0.8	1.0	0.8	0.9	0.7	40.3	0.66	145.5	0.66	145.5
2174	U/S	Wushi	Wushi Town	24-Jun-92	8.4	m	128.0	0.97	26.0	1.15	1.1	1.0	0.9	1.1	1.2	1.1						
2175	U/S	Wushi	Wushi Town	01-Aug-91	9.3	f	133.0	1.06	30.0	1.32	1.3	1.1	1.0	0.8	1.3	1.2						
2176	U/S	Wushi	Daqiao	05-Oct-87	13.1	m	147.2	1.18	32.5	1.06	1.1	0.9	1.1	1.1	1.1	0.9						
2177	U/S	Wushi	Autebeixi	17-Apr-87	13.5	f	136.0	0.97	23.5	0.77	0.9	0.8	0.9	1.1	1.0	0.9						
2178	U/S	Wushi	Wushi Town	03-Jul-91	9.3	f	126.0	0.94	25.0	0.77	1.1	0.8	0.9	1.1	1.0	0.7						
2179	Blood & U/S	Wushi	Wushi Town	07-Sep-92	8.2	m	125.0	0.88	21.5	0.68	0.9	1.0	0.9	0.7	0.9	1.0	1.2	48.1	1.30	115	1.30	115
2180	U/S	Wushi	Autebeixi	15-Aug-90	10.2	f	130.5	0.95	24.0	1.13	1.0	0.8	1.4	1.2	1.0	1.0						
2181	U/S	Wushi	Wushi Town	09-Feb-92	8.7	m	132.0	0.97	25.0	0.72	0.8	0.8	1.3	0.9	0.9	0.8						
2182	U/S	Wushi	Daqiao	05-Apr-87	13.6	m	149.8	1.27	38.0	7.09	1.9	1.7	2.3	2.1	2.0	1.7						
2183	U/S	Wushi	Autebeixi	15-Aug-90	10.2	f	138.5	0.95	22.0	0.81	1.0	0.9	0.8	0.9	1.0	1.1						
2184	U/S	Wushi	Autebeixi	10-Aug-90	10.2	f	131.0	0.96	24.5	1.18	1.3	1.0	1.1	1.0	1.1	0.9						
2185	U/S	Wushi	Daqiao	01-May-88	12.5	m	134.5	1.03	28.0	1.86	1.2	1.2	1.5	1.1	1.2	1.3						
2186	U/S	Wushi	Wushi Town	01-May-92	8.5	m	132.0	0.97	25.0	0.67	0.9	0.8	1.0	1.2	0.8	0.7						
2187	Blood & U/S	Wushi	Wushi Town	10-Oct-92	8.1	f	118.0	0.85	22.0	0.78	0.7	0.9	1.2	1.1	1.0	0.8	1.0	54.6	1.01	390	1.01	390
2188	Blood & U/S	Wushi	Wushi Town	08-Aug-92	8.2	m	122.0	0.93	26.0	0.80	1.0	0.9	1.1	0.9	1.0	0.7	0.8	56.6	1.15	810	1.15	810
2189	U/S	Wushi	Wushi Town	07-Jun-89	11.4	m	134.0	1.05	29.0	1.28	1.3	0.9	1.3	1.0	1.1	0.9						
2190	Blood & U/S	Wushi	Wushi Town	24-Jun-92	8.4	f	129.0	1.00	27.5	1.80	1.2	1.2	1.4	1.2	1.3	1.1	3.4	52.7	0.24	143	0.24	143
2191	Blood & U/S	Wushi	Wushi Town	01-Jan-91	9.8	m	128.0	1.03	30.0	0.70	1.1	1.1	0.8	0.5	1.1	0.9	0.8	52.0	0.48	480	0.48	480

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2192	U/S	Wushi	Autebeixi	10-Jun-88	12.4	m	141.5	1.03	25.5	0.81	0.7	0.9	1.1	1.2	0.8	1.0						
2193	U/S	Wushi	Wushi Town	11-Jul-91	9.3	f	127.0	0.98	27.0	0.93	0.8	1.0	1.2	1.1	1.0	0.9						
2194	U/S	Wushi	Wushi Town	01-Sep-91	9.2	m	132.0	1.00	27.0	0.73	1.1	0.9	0.8	0.9	0.9	0.9						
2195	U/S	Wushi	Wushi Town	13-Aug-91	9.2	f	119.0	0.85	22.0	0.86	0.8	0.9	1.0	1.1	1.0	1.0						
2196	U/S	Wushi	Wushi Town	01-Jun-92	8.4	m	121.0	0.85	21.0	0.64	0.7	0.8	1.2	0.8	0.9	0.9						
2197	U/S	Wushi	Wushi Town	25-Feb-92	8.7	f	116.0	0.82	21.0	1.37	1.2	1.1	0.9	1.1	1.3	1.2						
2198	Blood & U/S	Wushi	Wushi Town	12-Jul-92	8.3	f	128.0	0.93	24.0	0.78	1.1	0.8	1.1	0.6	1.1	0.6	1.0	59.8	0.67	460	0.67	460
2199	U/S	Wushi	Wushi Town	01-Jul-91	9.3	f	131.0	0.97	25.0	0.86	1.0	1.0	1.0	0.9	0.9	1.0						
2200	U/S	Wushi	Wushi Town	15-May-92	8.5	m	137.0	1.23	41.0	1.09	1.1	1.0	1.4	1.0	0.9	0.9						
2201	U/S	Wushi	Autebeixi	15-Sep-90	10.1	m	132.0	0.99	26.0	0.60	0.9	0.9	0.7	0.7	1.0	1.0						
2202	U/S	Wushi	Yimamu	05-Aug-92	8.2	f	122.5	0.87	22.0	1.70	1.1	1.3	1.4	1.4	1.0	1.1						
2203	U/S	Wushi	Yimamu	20-Mar-92	8.6	m	123.0	0.94	26.0	1.15	1.1	0.9	1.0	1.1	1.2	1.1						
2204	U/S	Wushi	Yimamu	01-Nov-91	9.0	m	130.0	1.01	28.0	2.35	1.4	1.3	1.5	1.2	1.3	1.4						
2205	U/S	Wushi	Autebeixi	15-Jun-88	12.4	m	140.5	0.95	21.5	0.95	0.8	1.0	1.1	1.1	1.0	1.0						
2206	U/S	Wushi	Autebeixi	25-Jul-90	10.3	f	134.0	0.91	21.0	0.65	0.9	0.9	0.9	0.7	0.9	1.0						
2207	Blood & U/S	Wushi	Yimamu	08-Apr-91	9.6	f	123.5	0.96	27.0	0.86	1.0	0.9	0.9	1.1	1.0	0.9	0.3	30.0	1.05	335	1.05	335
2208	U/S	Wushi	Yimamu	10-Jul-92	8.3	f	126.5	0.88	21.0	1.48	1.1	1.2	1.4	1.3	1.0	1.0						
2209	U/S	Wushi	Yimamu	17-May-91	9.5	f	130.0	0.96	25.0	1.16	1.2	0.9	1.0	1.1	1.2	1.0						
2210	U/S	Wushi	Autebeixi	20-Jul-90	10.3	f	127.5	0.91	22.5	0.89	1.0	0.9	0.9	1.2	1.1	0.8						
2211	U/S	Wushi	Autebeixi	23-Dec-90	9.9	m	137.5	1.05	28.0	1.13	1.5	1.1	0.6	0.9	1.4	1.1						
2212	U/S	Wushi	Yimamu	05-Jun-92	8.4	f	130.0	0.91	22.0	1.27	1.2	1.0	1.0	1.0	1.3	1.1						
2213	U/S	Wushi	Autebeixi	01-Sep-90	10.2	f	132.5	0.95	23.5	0.84	0.8	0.8	1.0	1.2	1.0	1.0						
2214	U/S	Wushi	Autebeixi	12-Oct-90	10.1	f	126.5	0.93	24.0	1.41	1.1	1.0	0.9	1.2	1.4	1.3						
2215	U/S	Wushi	Yimamu	17-May-91	9.5	f	131.5	1.05	30.0	1.11	1.1	1.1	1.0	0.9	1.2	1.0						
2216	Blood & U/S	Wushi	Autebeixi	13-Jun-89	11.4	m	137.0	1.05	28.0	1.22	1.3	0.8	1.1	1.3	1.2	0.8	0.0	59.2	4.60	490	4.60	490
2217	Blood & U/S	Wushi	Autebeixi	07-Jan-89	11.8	m	143.5	0.98	22.0	0.94	1.1	0.9	1.0	1.2	0.9	0.9	1.6	65.7	0.24	45	0.24	45
2218	U/S	Wushi	Autebeixi	15-Apr-90	10.6	m	140.0	0.95	21.5	1.32	1.1	1.1	1.2	1.3	1.0	1.0						
2219	U/S	Wushi	Yimamu	05-Mar-92	8.7	f	125.0	0.93	25.0	1.39	1.1	1.0	1.3	1.2	1.1	1.1						

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2220	U/S	Wushi	Autebeixi	15-Sep-90	10.1	f	124.0	0.81	18.0	1.06	0.9	1.0	1.3	1.3	0.9	0.9						
2221	U/S	Wushi	Autebeixi	15-May-90	10.5	f	126.5	0.90	22.5	0.57	1.0	1.0	0.8	0.8	0.7	0.8						
2222	U/S	Wushi	Autebeixi	31-Mar-90	10.6	f	135.0	0.94	22.0	1.37	1.4	1.2	0.8	0.9	1.4	1.2						
2223	U/S	Wushi	Autebeixi	25-Sep-88	12.1	f	145.0	1.00	22.5	1.32	1.3	1.2	1.0	0.9	1.2	1.1						
2224	U/S	Wushi	Autebeixi	15-Jul-90	10.3	f	127.5	0.96	25.5	1.86	1.3	1.3	1.3	1.1	1.2	1.3						
2225	U/S	Wushi	Autebeixi	15-May-90	10.5	m	134.5	0.94	22.5	1.00	1.1	1.0	1.1	1.1	0.9	0.9						
2226	U/S	Wushi	Yimamu	01-Jun-91	9.4	f	134.0	1.00	26.0	1.95	1.1	1.2	1.3	1.4	1.2	1.4						
2227	U/S	Wushi	Autebeixi	15-Sep-90	10.1	m	128.0	0.97	26.0	1.05	0.7	1.0	1.1	1.3	1.0	1.1						
2228	U/S	Wushi	Yimamu	27-Apr-92	8.5	f	130.0	0.91	22.0	0.86	0.9	0.9	1.0	1.1	0.9	1.0						
2229	U/S	Wushi	Yimamu	04-Dec-91	8.9	f	129.0	0.94	24.0	0.57	0.7	0.8	0.6	0.8	1.0	1.2						
2230	U/S	Wushi	Yimamu	20-May-92	8.5	f	131.0	1.01	28.0	1.48	1.2	1.2	1.3	1.4	0.9	1.0						
2231	U/S	Wushi	Yimamu	16-May-91	9.5	f	125.0	0.89	22.0	1.23	1.2	0.9	1.1	1.1	1.2	1.0						
2232	U/S	Wushi	Yimamu	12-Jun-92	8.4	m	126.5	0.94	25.0	0.73	1.0	0.9	1.0	1.0	0.8	0.8						
2233	U/S	Wushi	Autebeixi	15-Apr-90	10.6	m	134.0	0.97	24.5	0.54	0.7	0.6	0.8	1.4	0.8	0.8						
2234	U/S	Wushi	Yimamu	12-Apr-92	8.6	m	126.0	0.91	23.0	1.20	1.2	1.3	0.9	1.0	1.0	1.1						
2235	U/S	Wushi	Yimamu	01-Jun-90	10.4	m	131.5	0.97	25.0	1.10	1.2	1.1	1.1	0.8	1.0	1.1						
2236	U/S	Wushi	Yimamu	01-Apr-91	9.6	m	135.0	1.05	29.0	1.72	1.4	1.2	1.3	1.2	1.1	1.1						
2237	U/S	Wushi	Autebeixi	15-Sep-89	11.1	f	150.0	1.07	25.0	2.58	1.2	1.3	1.7	1.4	1.3	1.5						
2238	U/S	Wushi	Yimamu	03-Jun-91	9.4	m	131.0	1.01	28.0	1.04	1.1	1.1	0.8	1.0	1.1	1.1						
2239	U/S	Wushi	Autebeixi	01-Sep-91	9.2	f	131.0	0.93	23.0	0.91	1.1	0.8	1.0	1.1	1.0	0.9						
2240	U/S	Wushi	Yimamu	10-May-92	8.5	f	124.0	0.91	24.0	1.13	0.9	1.1	1.2	1.3	1.0	0.9						
2241	U/S	Wushi	Autebeixi	27-Feb-89	11.7	f	142.5	0.97	22.0	1.16	1.3	0.9	1.1	1.0	1.0	1.1						
2242	U/S	Wushi	Autebeixi	15-May-88	12.5	m	144.0	0.99	22.5	1.76	1.3	1.1	1.3	1.5	1.1	1.1						
2243	U/S	Wushi	Autebeixi	12-Sep-89	11.1	f	151.6	1.01	21.5	2.50	1.2	1.3	1.6	1.1	1.6	1.5						
2244	Blood & U/S	Wushi	Autebeixi	01-Mar-89	11.7	m	134.0	0.97	24.0	1.58	1.2	1.1	1.4	1.2	1.1	1.1	1.3	43.6	0.25	355	0.25	355
2245	U/S	Wushi	Yimamu	14-Sep-91	9.1	f	123.0	0.88	22.0	0.57	0.7	0.9	0.9	1.1	0.8	0.7						
2246	U/S	Wushi	Yimamu	23-Aug-91	9.2	f	129.5	0.93	23.0	0.89	0.8	1.1	1.0	1.2	1.0	0.8						
2247	U/S	Wushi	Yimamu	10-Apr-92	8.6	m	129.0	1.00	28.0	1.39	1.1	1.2	1.2	1.1	1.2	1.0						

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2248	U/S	Wushi	Yimamu	19-Nov-91	9.0	f	129.0	0.94	24.0	0.77	1.0	1.0	0.9	0.7	1.0	1.0						
2249	U/S	Wushi	Yimamu	01-May-92	8.5	f	122.0	0.82	19.0	1.09	1.0	0.9	1.1	1.3	0.9	1.1						
2250	U/S	Wushi	Yimamu	15-Sep-91	9.1	f	134.0	1.06	30.0	0.49	0.8	0.9	0.8	0.8	0.7	0.8						
2251	Blood & U/S	Wushi	Yimamu	01-Jun-91	9.4	f	130.5	0.95	24.0	0.86	1.0	0.9	1.0	1.1	0.9	0.9	2.4	48.8	0.58	250	0.58	250
2252	U/S	Wushi	Autebeixi	15-May-90	10.5	m	137.5	1.05	28.0	1.32	1.1	1.2	1.2	1.2	1.1	0.9						
2253	U/S	Wushi	Yimamu	12-May-92	8.5	f	126.0	0.97	27.0	1.04	1.0	1.2	1.1	1.0	1.0	0.9						
2254	U/S	Wushi	Yimamu	12-Jul-92	8.3	f	124.0	0.85	20.0	1.06	1.1	1.1	1.1	0.7	1.2	1.0						
2255	U/S	Wushi	Yimamu	12-Jun-93	7.4	f	126.0	0.91	23.0	0.77	1.0	0.9	0.9	1.1	0.9	0.8						
2256	U/S	Wushi	Yimamu	21-Sep-91	9.1	m	132.0	1.02	28.0	0.65	0.9	0.7	1.0	1.1	0.9	0.7						
2257	U/S	Wushi	Yimamu	15-Sep-91	9.1	f	132.0	1.02	28.0	0.65	1.1	1.2	0.8	0.5	1.0	0.8						
2258	U/S	Wushi	Yimamu	30-Jan-91	9.8	f	122.0	0.87	22.0	1.04	1.0	1.2	1.0	0.9	1.1	1.0						
2259	U/S	Wushi	Yimamu	02-Sep-91	9.2	f	121.0	0.88	23.0	0.85	1.0	0.9	0.9	0.8	1.1	1.1						
2260	Blood & U/S	Wushi	Yimamu	21-Sep-91	9.1	m	130.0	0.93	23.0	1.49	1.2	1.2	1.4	1.2	1.0	1.0	0.3	59.8	1.15/0.66	150	0.91	150
2261	U/S	Wushi	Yimamu	01-Aug-91	9.3	m	131.5	1.00	27.0	1.08	1.3	1.0	0.8	0.9	1.3	1.0						
2262	U/S	Wushi	Autebeixi	18-Jul-90	10.3	f	124.0	0.90	23.0	0.94	1.1	1.0	0.8	0.9	1.1	1.1						
2263	Blood & U/S	Wushi	Yimamu	21-Jan-91	9.8	f	131.5	0.97	25.0	1.10	1.2	1.0	1.1	1.0	0.9	1.1	0.5	40.9	0.45	307/303	0.45	305
2264	U/S	Wushi	Autebeixi	15-Jul-90	10.3	f	128.0	0.93	23.5	1.03	1.2	0.9	0.9	0.9	1.1	1.2						
2265	U/S	Wushi	Yimamu	10-Apr-90	10.6	f	129.0	1.02	29.0	1.14	0.9	1.0	1.1	1.3	1.1	1.0						
2266	U/S	Wushi	Yimamu	27-Oct-90	10.0	m	140.0	1.14	33.0	1.84	1.5	1.3	1.1	1.1	1.2	1.3						
2267	Blood & U/S	Wushi	Yimamu	29-Dec-90	9.8	m	135.5	1.02	27.0	1.32	1.4	1.1	0.9	0.7	1.4	1.3	0.4	23.4	1.10	400/400	1.10	400
2268	U/S	Wushi	Yimamu	10-Apr-92	8.6	f	119.0	0.84	21.0	1.02	1.0	0.9	1.2	1.3	0.8	1.0						
2269	U/S	Wushi	Yimamu	16-May-91	9.5	f	118.5	0.82	20.0	1.38	1.3	1.1	1.0	1.0	1.2	1.2						
2270	Blood & U/S	Wushi	Yimamu	07-Nov-92	8.0	f	128.0	0.95	25.0	1.03	1.1	1.0	1.0	1.3	0.9	0.9	0.9	66.9	0.40	125.5	0.40	125.5
2271	U/S	Wushi	Yimamu	07-Dec-92	7.9	m	132.0	1.00	27.0	0.69	1.0	0.8	0.8	1.0	1.0	0.8						
2272	U/S	Wushi	Yimamu	11-Aug-91	9.2	m	132.3	0.97	25.0	0.47	0.7	0.6	0.9	1.0	0.9	0.7						
2273	U/S	Wushi	Autebeixi	25-Oct-90	10.0	m	139.0	1.03	26.0	1.05	1.1	1.2	0.9	1.0	1.0	1.0						
2274	U/S	Wushi	Yimamu	01-Jun-90	10.4	m	135.0	1.07	30.0	1.09	1.2	1.1	0.9	0.9	1.1	1.1						
2275	U/S	Wushi	Autebeixi	01-Jul-90	10.3	f	128.0	0.93	24.0	0.94	0.9	0.8	1.0	1.1	1.2	1.0						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
2276	U/S	Wushi	Autebeixi	10-Aug-90	10.2	m	145.5	0.98	21.5	0.95	1.1	0.9	1.0	1.1	1.0	0.9						
2277	U/S	Wushi	Yimamu	15-Nov-91	9.0	f	135.0	0.99	25.0	1.99	1.1	1.3	1.5	1.5	1.1	1.2						
2278	U/S	Wushi	Yimamu	07-Aug-92	8.2	f	124.0	0.90	23.0	0.86	0.9	0.9	1.0	1.1	0.9	1.0						
2279	Blood & U/S	Wushi	Autebeixi	15-Aug-89	11.2	f	145.0	1.00	23.0	1.37	1.0	1.0	1.3	1.3	1.2	1.0	0.7	55.3	0.28	445	0.28	445
2280	Blood & U/S	Wushi	Yimamu	15-Nov-92	8.0	f	126.5	0.93	24.5	0.95	1.1	1.1	1.0	0.8	1.0	1.0	2.5	50.1	0.68	270/265	0.68	268
2281	U/S	Wushi	Autebeixi	15-Jun-89	11.4	f	145.8	1.22	36.0	2.14	1.4	1.2	1.1	1.1	1.7	1.4						
2282	Blood & U/S	Wushi	Autebeixi	04-Jan-89	11.8	m	136.5	0.98	24.0	1.28	1.1	0.8	1.0	1.4	1.2	1.2	0.6	42.9	0.38	17	0.38	17
2283	U/S	Wushi	Autebeixi	12-Mar-90	10.6	m	131.5	1.02	28.0	0.55	1.0	0.8	0.7	0.8	0.9	0.8						
2284	U/S	Wushi	Autebeixi	21-Sep-90	10.1	f	132.8	1.00	26.5	1.16	1.0	1.1	1.1	0.9	1.4	0.9						
2285	U/S	Wushi	Yimamu	05-Nov-91	9.0	f	130.0	0.95	24.0	1.06	1.3	1.1	0.7	1.0	1.1	1.1						
2286	U/S	Wushi	Autebeixi	15-Jul-90	10.3	m	115.5	0.79	19.5	1.15	1.1	1.0	1.0	0.9	1.2	1.2						
2287	U/S	Wushi	Autebeixi	03-Sep-90	10.2	f	135.6	1.04	28.0	1.05	1.1	1.1	0.9	1.0	1.0	1.1						
2288	Blood & U/S	Wushi	Yimamu	01-Jun-91	9.4	m	133.5	0.91	21.0	1.75	1.0	1.1	1.4	1.6	1.1	1.2	0.0	54.6	0.44	358	0.44	358
2289	Blood & U/S	Wushi	Autebeixi	03-May-88	12.5	m	146.5	0.99	22.0	1.49	1.4	1.1	1.2	1.3	1.0	1.0	0.7	44.2	0.55	455	0.55	455
2290	U/S	Wushi	Yimamu	24-Nov-91	8.9	f	134.5	0.97	24.0	0.74	0.9	0.9	1.0	0.9	1.0	0.8						
2291	U/S	Wushi	Yimamu	05-Aug-92	8.2	f	129.0	0.87	20.0	0.82	0.9	1.0	1.0	1.0	0.8	1.0						
2292	U/S	Wushi	Yimamu	28-Jan-91	9.8	m	130.0	0.95	24.0	0.86	0.9	0.9	0.9	1.1	1.0	1.0						
2293	U/S	Wushi	Autebeixi	06-Sep-90	10.2	f	125.0	0.81	18.0	0.63	0.8	0.6	0.9	1.0	1.0	1.0						
2294	U/S	Wushi	Yimamu	01-Jun-89	11.4	m	138.0	1.07	29.0	0.97	0.8	1.2	1.2	0.8	1.1	1.0						
2295	Blood & U/S	Wushi	Yimamu	21-Nov-91	8.9	m	130.0	1.01	28.0	1.30	1.2	1.1	1.2	0.7	1.3	1.1	0.0	22.1	0.11	110	0.11	110
2296	U/S	Wushi	Yimamu	10-May-92	8.5	m	124.0	0.00	nd	0.27	0.9	0.9	0.9	0.8	0.7	0.0						
2297	U/S	Wushi	Autebeixi	29-Jun-89	11.3	f	142.0	1.07	27.5	1.64	1.1	1.2	1.5	1.0	1.2	1.2						
2298	U/S	Wushi	Autebeixi	18-Jul-89	11.3	f	133.6	1.01	27.0	1.79	1.3	1.2	1.4	1.2	1.1	1.2						
2299	Blood & U/S	Wushi	Autebeixi	17-Nov-89	11.0	f	147.0	1.14	30.0	0.61	1.1	0.7	0.9	1.2	0.7	0.7	0.9	33.8	1.55	355	1.55	355
2300	U/S	Wushi	Yimamu	01-Dec-92	7.9	f	126.0	0.91	23.0	0.80	0.9	1.1	0.9	0.8	1.2	0.8						
2311	Blood & U/S	Wushi	Yimamu	24-May-91	9.4	m	131.0	1.01	28.0	3.26	1.6	1.4	1.7	1.5	1.5	1.3	0.3	53.9	0.50	200	0.50	200
2376	U/S	Wushi	Yimamu	20-Aug-92	8.2	m	119.0	0.80	19.0	1.38	1.4	1.2	1.0	1.0	1.2	1.0						
3001	U/S	Kuqa	Sandaqiao	10-Sep-92	8.1	f	130.0	0.95	24.0	0.77	0.8	1.0	0.5	1.1	1.0	1.1						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3002	U/S	Kuqa	Qiman	08-Sep-92	8.1	f	125.0	0.87	21.0	0.48	0.9	0.7	0.8	0.8	0.7	0.9						
3003	U/S	Kuqa	Qiman	19-Feb-93	7.6	f	113.0	0.81	21.0	0.69	0.9	0.8	0.8	0.9	0.9	1.1						
3004	U/S	Kuqa	Sandaqiao	06-Apr-92	8.5	m	125.5	0.98	28.0	1.56	1.3	1.0	1.2	1.4	1.1	1.1						
3005	U/S	Kuqa	Sandaqiao	10-May-92	8.4	m	133.0	1.03	28.0	1.46	1.1	0.9	0.7	1.2	1.3	1.9						
3006	U/S	Kuqa	Sandaqiao	10-Nov-91	8.9	m	124.0	0.95	26.0	0.80	0.9	0.6	1.4	1.0	0.9	0.9						
3007	U/S	Kuqa	Qiman	03-Nov-91	8.9	m	121.0	0.83	20.0	0.86	1.0	0.8	0.9	1.0	1.2	0.9						
3008	U/S	Kuqa	Qiman	01-Apr-93	7.5	m	125.0	0.92	24.0	0.60	0.6	0.9	1.0	1.0	0.9	0.8						
3009	U/S	Kuqa	Qiman	18-Sep-92	8.1	f	115.0	0.82	21.0	0.57	0.7	0.7	0.9	1.1	0.8	0.9						
3010	U/S	Kuqa	Sandaqiao	21-Nov-91	8.9	m	124.0	0.95	26.0	0.95	1.1	1.1	1.0	0.9	1.0	0.9						
3011	Blood & U/S	Kuqa	Sandaqiao	30-Apr-91	9.5	f	132.5	0.98	25.0	0.78	0.9	1.0	0.6	1.2	0.8	1.0	0.0	35.1	3.30	700/695	3.30	698
3012	U/S	Kuqa	Qiman	02-Sep-91	9.1	m	122.5	0.91	24.0	0.91	1.0	0.9	1.1	1.0	1.0	0.9						
3013	U/S	Kuqa	Sandaqiao	08-Jul-91	9.3	f	131.5	0.99	26.0	1.78	1.4	1.0	1.4	1.3	1.1	1.2						
3014	U/S	Kuqa	Sandaqiao	08-Oct-91	9.0	m	130.0	1.01	28.0	1.23	1.1	0.9	1.3	1.4	1.0	0.9						
3015	U/S	Kuqa	Qiman	11-Dec-92	7.8	m	129.5	1.01	28.0	1.21	1.3	1.1	1.0	0.9	1.1	1.1						
3016	Blood & U/S	Kuqa	Sandaqiao	30-Jan-92	8.7	m	136.0	1.01	26.0	0.51	0.6	0.9	0.8	1.0	0.7	0.8	0.2	53.3	1.40	35	1.40	35
3017	U/S	Kuqa	Sandaqiao	28-Dec-91	8.8	f	123.0	0.91	24.0	0.95	1.1	1.1	0.8	0.7	1.2	1.2						
3018	U/S	Kuqa	Sandaqiao	18-Sep-91	9.1	m	119.0	0.84	21.0	0.76	0.9	0.8	0.9	1.2	1.0	0.8						
3019	U/S	Kuqa	Qiman	04-Feb-93	7.7	f	115.0	0.77	18.0	1.09	1.2	1.1	0.9	0.9	1.1	1.1						
3020	U/S	Kuqa	Sandaqiao	05-Dec-91	8.9	m	130.5	0.93	23.0	0.93	0.9	0.9	1.2	1.2	0.9	0.9						
3021	U/S	Kuqa	Sandaqiao	10-Nov-91	8.9	m	117.5	0.80	19.0	0.62	0.8	0.9	1.0	0.8	0.9	0.8						
3022	U/S	Kuqa	Sandaqiao	08-May-92	8.4	f	120.0	0.88	23.0	2.07	1.5	1.5	1.1	1.3	1.2	1.2						
3023	U/S	Kuqa	Sandaqiao	04-Nov-93	6.9	m	120.0	0.86	22.0	0.81	1.1	0.9	0.8	1.0	1.0	0.9						
3024	Blood & U/S	Kuqa	Sandaqiao	15-Aug-92	8.2	f	124.0	0.93	25.0	1.19	1.2	0.8	1.1	1.3	1.1	1.0	3.1	44.9	1.90	265	1.90	265
3025	U/S	Kuqa	Sandaqiao	18-Nov-91	8.9	m	123.0	0.86	21.0	1.05	1.1	0.8	1.7	0.9	0.9	0.7						
3026	U/S	Kuqa	Qiman	01-Apr-93	7.5	f	128.0	0.90	22.0	0.61	0.7	0.8	0.9	1.1	0.9	0.8						
3027	U/S	Kuqa	Sandaqiao	15-May-91	9.4	m	136.5	1.11	32.0	1.28	1.0	1.3	0.9	0.9	1.4	1.2						
3028	U/S	Kuqa	Qiman	19-Sep-91	9.1	m	118.0	0.88	24.0	0.84	0.9	0.9	0.8	0.9	1.2	1.1						
3029	Blood & U/S	Kuqa	Sandaqiao	27-Sep-91	9.0	f	127.0	0.93	24.0	1.13	1.0	0.9	1.3	1.6	0.7	1.0	1.7	66.3	0.48/0.48	372	0.48	372

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3030	U/S	Kuqa	Qiman	16-Oct-92	8.0	m	121.5	0.87	22.0	1.58	1.2	1.0	1.3	1.3	1.2	1.1						
3031	U/S	Kuqa	Qiman	19-Sep-91	9.1	f	128.0	0.93	24.0	0.31	0.5	0.7	0.7	0.8	0.7	0.7						
3032	U/S	Kuqa	Qiman	07-May-92	8.4	m	128.0	0.90	22.0	0.90	1.1	0.9	0.9	0.9	1.0	1.1						
3033	U/S	Kuqa	Sandaqiao	07-Oct-91	9.0	f	133.0	0.99	26.0	0.90	0.9	0.9	0.7	1.1	1.1	1.2						
3034	U/S	Kuqa	Qiman	02-Apr-92	8.5	m	129.0	0.89	21.0	1.14	1.1	1.1	1.0	1.3	1.0	0.9						
3035	U/S	Kuqa	Sandaqiao	15-Oct-91	9.0	m	127.5	0.92	23.0	0.61	1.1	0.8	0.7	0.8	1.0	0.8						
3036	U/S	Kuqa	Sandaqiao	14-Mar-92	8.6	f	122.5	0.89	23.0	0.86	1.0	0.8	1.1	1.1	1.0	0.8						
3037	U/S	Kuqa	Sandaqiao	09-May-92	8.4	f	130.0	0.98	26.0	1.08	1.2	1.0	1.1	1.0	1.1	0.8						
3038	U/S	Kuqa	Sandaqiao	06-Nov-91	8.9	m	130.0	0.98	26.0	1.18	1.2	1.0	0.8	0.8	1.4	1.4						
3039	U/S	Kuqa	Sandaqiao	09-Oct-91	9.0	m	nd	nd	nd	1.43	1.4	1.0	0.8	1.0	1.6	1.2						
3040	U/S	Kuqa	Qiman	21-Oct-91	9.0	f	121.0	0.85	21.0	0.90	1.2	0.9	0.8	0.7	1.1	1.3						
3041	U/S	Kuqa	Sandaqiao	08-Oct-90	10.0	f	130.0	0.91	22.0	0.72	0.8	0.8	1.0	0.8	1.0	1.1						
3042	U/S	Kuqa	Sandaqiao	15-Feb-92	8.7	m	129.0	0.99	27.0	1.33	1.1	1.1	1.3	1.2	1.2	0.8						
3043	U/S	Kuqa	Sandaqiao	10-Sep-91	9.1	f	132.5	0.98	25.0	0.69	0.9	0.9	0.9	1.1	0.8	0.8						
3044	U/S	Kuqa	Sandaqiao	05-Oct-91	9.0	m	131.0	1.05	30.0	1.44	1.2	1.1	1.0	1.2	1.4	1.0						
3045	U/S	Kuqa	Qiman	06-Jul-93	7.3	m	118.5	0.87	23.0	1.36	1.3	1.2	0.8	1.1	1.2	1.2						
3046	U/S	Kuqa	Qiman	16-Apr-93	7.5	m	110.5	0.76	19.0	0.70	1.1	1.1	0.7	0.9	1.0	0.7						
3047	U/S	Kuqa	Qiman	17-May-92	8.4	f	125.0	0.89	22.5	0.85	0.8	0.9	1.1	1.0	1.0	1.0						
3048	U/S	Kuqa	Qiman	03-Nov-92	7.9	m	122.5	0.89	23.0	1.14	1.1	0.9	1.0	1.3	1.0	1.1						
3049	U/S	Kuqa	Qiman	07-Sep-92	8.1	m	119.5	0.90	25.0	0.95	1.0	1.1	1.1	0.8	1.0	1.0						
3050	U/S	Kuqa	Qiman	03-Oct-91	9.0	m	134.0	1.02	27.0	0.80	1.0	1.0	1.1	1.0	0.8	0.8						
3051	U/S	Kuqa	Qiman	23-Sep-92	8.0	m	108.0	0.76	20.0	0.65	1.0	1.0	0.7	0.6	1.0	1.1						
3052	U/S	Kuqa	Sandaqiao	01-Sep-91	9.1	f	138.0	1.10	31.0	1.53	1.2	1.0	1.4	1.3	1.2	0.9						
3053	U/S	Kuqa	Qiman	06-Oct-91	9.0	f	123.5	0.88	22.0	1.03	1.2	0.9	1.1	0.9	0.9	1.2						
3054	Blood & U/S	Kuqa	Qiman	09-Nov-90	9.9	f	125.5	0.94	25.0	1.16	1.1	1.1	0.9	1.1	1.1	1.1	0.9	41.7	2.75	510/514	2.75	512
3055	U/S	Kuqa	Qiman	24-Nov-91	8.9	m	118.5	0.85	22.0	0.73	1.0	0.8	1.1	1.0	0.8	0.8						
3056	Blood & U/S	Kuqa	Sandaqiao	01-Dec-91	8.9	m	132.5	0.94	23.0	1.36	1.0	1.2	1.4	1.2	0.9	1.1	1.3	55.9	0.60	65	0.60	65
3057	Blood & U/S	Kuqa	Qiman	09-Sep-92	8.1	m	128.0	0.93	24.0	0.78	1.1	0.8	0.7	0.7	1.1	1.4	0.3	37.7	5.00	70	5.00	70

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3058	U/S	Kuqa	Sandaqiao	14-Oct-90	10.0	f	133.0	1.01	27.0	0.91	0.9	0.8	1.2	1.0	1.1	0.9						
3059	U/S	Kuqa	Sandaqiao	13-Oct-91	9.0	f	124.0	0.90	23.0	0.95	1.0	0.9	1.0	1.1	1.1	0.9						
3060	U/S	Kuqa	Qiman	01-Mar-92	8.6	m	135.0	1.08	31.0	1.09	1.4	1.1	0.7	0.7	1.3	1.3						
3061	U/S	Kuqa	Sandaqiao	05-Dec-91	8.9	m	128.0	0.98	27.0	2.09	1.1	1.1	1.7	1.6	1.3	1.1						
3062	U/S	Kuqa	Sandaqiao	08-Aug-92	8.2	f	122.0	0.82	19.0	1.08	1.4	1.0	0.7	1.3	1.1	0.9						
3063	Blood & U/S	Kuqa	Qiman	01-Jan-91	9.8	m	130.0	0.98	26.0	1.33	1.3	1.0	1.1	1.1	1.1	1.1	0.6	42.9	4.9/4.7	470	4.80	470
3064	U/S	Kuqa	Sandaqiao	18-Nov-91	8.9	m	128.0	0.93	24.0	0.83	1.0	0.9	1.0	1.0	1.1	0.7						
3065	Blood & U/S	Kuqa	Sandaqiao	07-Nov-91	8.9	f	130.5	0.98	26.0	0.88	0.9	1.1	0.7	1.0	1.0	1.1	1.2	48.8	0.78	93	0.78	93
3066	Blood & U/S	Kuqa	Qiman	09-May-93	7.4	m	123.5	0.93	25.0	1.37	1.5	1.2	0.6	0.9	1.5	1.4	0.6	39.0	2.6/2.85	345	2.73	345
3067	U/S	Kuqa	Qiman	10-Nov-91	8.9	m	134.0	1.04	28.5	1.44	1.2	0.8	1.2	1.5	1.0	1.3						
3068	U/S	Kuqa	Qiman	04-Feb-92	8.7	f	121.5	0.88	23.0	0.66	0.8	0.9	0.9	0.9	0.8	1.0						
3069	Blood & U/S	Kuqa	Qiman	05-Oct-92	8.0	m	121.5	0.87	22.0	0.95	1.1	0.9	0.9	1.0	1.0	1.1	1.0	23.4	2.90	327/325	2.90	326
3070	U/S	Kuqa	Qiman	17-Sep-91	9.1	f	130.0	1.02	29.0	1.51	1.0	1.2	1.1	1.3	1.3	1.1						
3071	Blood & U/S	Kuqa	Qiman	10-Sep-92	8.1	f	106.5	0.79	22.0	0.59	0.8	0.6	0.9	0.9	0.9	1.1	1.3	46.2	1.3/2	180	1.65	180
3072	Blood & U/S	Kuqa	Sandaqiao	11-Jun-92	8.3	f	130.5	0.96	25.0	0.71	1.2	0.8	0.7	0.8	1.0	1.0	0.0	43.6	0.32	54	0.32	54
3073	U/S	Kuqa	Sandaqiao	13-Dec-91	8.8	f	125.5	0.85	20.0	1.14	1.0	1.1	1.0	0.9	1.2	1.2						
3074	U/S	Kuqa	Sandaqiao	12-Aug-92	8.2	f	123.0	0.84	20.0	0.54	1.0	0.7	0.8	1.0	0.8	0.7						
3075	U/S	Kuqa	Sandaqiao	05-Apr-92	8.5	f	120.5	0.86	22.0	0.73	0.9	0.9	0.7	1.1	1.0	0.9						
3076	U/S	Kuqa	Sandaqiao	08-Oct-92	8.0	m	132.0	0.96	24.0	0.76	0.9	0.8	0.9	1.2	0.9	0.9						
3077	Blood & U/S	Kuqa	Qiman	22-Jun-92	8.3	f	108.0	0.80	22.0	0.63	0.9	0.9	0.7	0.7	1.1	1.0	1.3	36.4	0.66/0.59	720	0.63	720
3078	U/S	Kuqa	Qiman	07-Nov-92	7.9	m	114.5	0.86	24.0	1.00	1.1	0.9	0.9	1.0	1.2	1.0						
3079	U/S	Kuqa	Sandaqiao	10-Jul-90	10.3	m	125.0	0.93	25.0	1.09	1.0	1.2	1.2	1.0	0.9	1.0						
3080	U/S	Kuqa	Sandaqiao	25-Apr-91	9.5	m	128.0	0.95	25.0	0.67	0.9	0.7	0.8	1.3	0.8	0.9						
3081	U/S	Kuqa	Sandaqiao	09-Oct-90	10.0	f	130.0	0.96	25.0	1.06	1.2	1.2	1.1	0.8	1.1	0.8						
3082	Blood & U/S	Kuqa	Sandaqiao	25-Oct-91	9.0	m	120.0	0.88	23.0	1.27	0.9	1.0	1.4	1.4	1.0	1.0	1.2	65.6	0.27	185	0.27	185
3083	U/S	Kuqa	Sandaqiao	05-Dec-91	8.9	f	128.0	0.98	27.0	0.82	1.0	0.7	1.2	1.4	0.7	0.9						
3084	Blood & U/S	Kuqa	Sandaqiao	12-May-91	9.4	m	121.8	0.90	24.0	0.61	0.9	1.2	0.6	1.3	0.9	0.5	0.7	34.5	1.15	912	1.15	912
3085	Blood & U/S	Kuqa	Qiman	15-Oct-92	8.0	m	126.5	0.97	27.0	1.34	1.2	1.1	1.4	1.3	0.9	0.9	2.0	44.2	4.60	335	4.60	335

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3086	U/S	Kuqa	Sandaqiao	05-Aug-91	9.2	m	139.5	1.03	26.0	1.04	0.9	1.1	1.1	1.0	1.2	0.9						
3087	U/S	Kuqa	Sandaqiao	04-May-91	9.4	m	135.5	1.04	28.0	0.95	0.9	1.1	1.1	1.1	0.9	0.9						
3088	U/S	Kuqa	Sandaqiao	14-Nov-91	8.9	f	118.0	0.88	24.0	1.42	0.9	1.1	1.4	1.1	1.2	1.2						
3089	U/S	Kuqa	Sandaqiao	12-Feb-92	8.7	f	116.0	0.82	21.0	0.62	0.7	1.0	1.0	0.9	0.7	0.9						
3090	U/S	Kuqa	Sandaqiao	04-Nov-91	8.9	f	130.0	0.99	27.0	1.14	1.1	1.3	1.1	0.9	1.0	1.0						
3091	U/S	Kuqa	Qiman	05-Jan-92	8.8	f	124.5	0.93	25.0	1.78	1.4	1.5	0.8	1.0	1.3	1.5						
3092	U/S	Kuqa	Sandaqiao	03-Dec-91	8.9	m	120.5	0.89	24.0	0.84	1.1	1.1	0.7	0.9	1.0	1.0						
3093	U/S	Kuqa	Sandaqiao	12-Aug-92	8.2	f	128.0	0.94	24.5	0.64	1.0	1.1	0.9	0.6	0.9	0.8						
3094	U/S	Kuqa	Sandaqiao	22-Jul-91	9.2	m	125.0	0.92	24.0	0.81	1.0	1.0	0.8	0.9	1.1	0.9						
3095	U/S	Kuqa	Sandaqiao	03-May-92	8.4	f	131.0	0.98	26.0	1.01	0.9	1.1	1.1	1.1	0.9	1.0						
3096	U/S	Kuqa	Qiman	08-Oct-92	8.0	f	118.5	0.80	19.0	0.73	1.2	0.9	0.5	0.9	1.2	1.0						
3097	U/S	Kuqa	Sandaqiao	03-Nov-91	8.9	f	121.5	0.87	22.0	1.13	1.0	0.9	0.9	1.1	1.3	1.2						
3098	U/S	Kuqa	Sandaqiao	18-Jan-92	8.7	f	123.5	0.91	24.0	0.95	0.9	1.0	0.8	1.2	1.1	1.0						
3099	Blood & U/S	Kuqa	Sandaqiao	17-Dec-91	8.8	m	127.5	0.93	24.0	0.29	0.9	0.6	0.6	0.7	0.8	0.4	0.6	24.7	1.25	282/277	1.25	280
3100	U/S	Kuqa	Qiman	13-Aug-93	7.2	m	122.0	0.87	22.0	0.91	1.1	1.0	0.8	1.0	0.9	1.1						
3101	U/S	Kuqa	Qiman	21-Feb-93	7.6	m	130.0	0.99	27.0	1.60	1.1	1.1	1.1	1.0	1.4	1.5						
3102	U/S	Kuqa	Wuzun	10-May-93	7.4	m	123.0	0.88	22.0	0.81	1.3	0.9	0.6	1.2	1.2	0.7						
3103	U/S	Kuqa	Yaha	19-Oct-91	9.0	m	133.0	1.03	28.0	0.65	1.0	0.9	0.7	0.9	1.0	0.8						
3104	Blood & U/S	Kuqa	Yaha	09-Jul-92	8.3	f	128.0	0.92	23.0	0.86	0.9	0.9	1.0	0.9	1.1	1.0	2.0	30.6	0.75/0.62	85	0.69	85
3105	U/S	Kuqa	Yaha	01-Sep-92	8.1	f	113.0	0.74	17.0	0.44	0.7	0.7	1.0	1.0	0.8	0.5						
3106	U/S	Kuqa	Yaha	17-Sep-91	9.1	m	128.0	0.88	21.0	0.43	1.0	0.7	0.8	1.2	0.6	0.5						
3107	Blood & U/S	Kuqa	Yaha	27-Sep-92	8.0	m	128.0	0.92	23.0	0.86	0.9	0.9	1.0	1.0	1.0	1.0	2.7	25.4	0.87	235	0.87	235
3108	U/S	Kuqa	Yaha	07-Aug-93	7.2	m	116.0	0.84	22.0	0.60	0.9	0.9	1.0	1.0	0.7	0.7						
3109	Blood & U/S	Kuqa	Yaha	03-Dec-92	7.9	m	127.0	0.99	28.0	1.47	1.1	1.0	1.0	1.0	1.6	1.3	0.6	42.3	0.58	305	0.58	305
3110	U/S	Kuqa	Yaha	08-Feb-93	7.7	m	131.0	0.98	26.0	0.61	0.7	1.0	0.9	1.0	0.6	0.9						
3111	U/S	Kuqa	Qiman	03-Nov-92	7.9	m	112.0	0.79	20.0	0.87	1.2	0.9	0.9	0.9	1.0	0.9						
3112	U/S	Kuqa	Yaha	18-Apr-93	7.5	f	128.0	0.93	24.0	0.66	0.9	1.0	0.7	0.9	0.9	0.9						
3113	Blood & U/S	Kuqa	Yaha	09-Jan-92	8.8	m	130.0	0.98	26.0	0.47	1.0	0.8	0.6	0.8	0.9	0.7	2.7	46.2	0.80	205	0.80	205

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3114	U/S	Kuqa	Wuzun	04-Apr-92	8.5	f	123.0	0.91	24.0	1.23	1.3	1.0	0.6	1.2	1.3	1.3						
3115	U/S	Kuqa	Yaha	07-Sep-91	9.1	m	140.0	1.08	29.0	0.93	1.0	0.8	1.0	1.3	0.9	1.0						
3116	U/S	Kuqa	Yaha	11-Sep-92	8.1	f	124.0	0.95	26.0	0.75	1.0	1.2	0.8	0.7	0.9	1.0						
3117	Blood & U/S	Kuqa	Yaha	nd	nd	f	127.0	0.93	24.0	0.73	1.1	0.9	0.6	0.8	1.0	1.2	1.9	40.9	0.55	150	0.55	150
3118	U/S	Kuqa	Yaha	11-Sep-92	8.1	f	127.0	0.88	21.0	0.81	1.0	0.9	1.1	1.1	0.9	0.7						
3119	U/S	Kuqa	Yaha	18-Jan-92	8.7	m	126.0	0.91	23.0	0.37	1.1	0.9	0.6	1.0	0.5	0.5						
3120	U/S	Kuqa	Wuzun	10-Dec-93	6.8	f	120.0	0.83	20.0	0.71	0.8	0.9	0.9	1.0	0.8	1.0						
3121	Blood & U/S	Kuqa	Qiman	11-Mar-93	7.6	f	120.5	0.71	14.0	0.82	1.2	0.8	0.7	1.0	0.9	1.2	1.0	43.6	2.75	478	2.75	478
3122	Blood & U/S	Kuqa	Qiman	05-Dec-91	8.9	f	131.0	1.00	27.0	0.72	0.9	0.9	1.3	1.1	0.6	0.8	0.0	40.3	3.70	810	3.70	810
3123	Blood & U/S	Kuqa	Yaha	21-Mar-92	8.6	f	113.0	0.76	18.0	0.19	0.6	0.7	0.5	0.4	0.7	0.7	0.3	33.2	0.55	255/262	0.55	259
3124	U/S	Kuqa	Yaha	28-Nov-93	6.9	m	118.0	0.83	21.0	0.73	0.9	0.9	0.9	0.8	1.0	1.0						
3125	U/S	Kuqa	Qiman	01-Dec-92	7.9	f	122.5	0.86	21.0	1.20	1.2	1.0	0.9	1.2	1.1	1.1						
3126	U/S	Kuqa	Wuzun	25-Aug-93	7.1	f	118.0	0.80	19.0	0.99	0.8	1.0	1.4	1.3	0.8	0.9						
3127	U/S	Kuqa	Yaha	07-Sep-92	8.1	f	134.0	0.97	24.0	0.58	0.9	1.0	1.0	0.7	0.8	0.7						
3128	U/S	Kuqa	Wuzun	14-Jun-93	7.3	f	128.0	0.93	24.0	0.52	1.1	0.9	0.6	0.6	0.9	0.9						
3129	Blood & U/S	Kuqa	Yaha	09-Oct-93	7.0	f	117.0	0.77	18.0	0.61	1.2	1.0	0.6	0.7	1.0	0.8	0.8	48.8	0.55	62	0.55	62
3130	U/S	Kuqa	Yaha	19-Nov-92	7.9	f	124.0	0.86	21.0	0.59	1.0	0.8	0.8	0.8	0.9	0.8						
3131	Blood & U/S	Kuqa	Wuzun	02-Aug-93	7.2	f	114.0	0.78	19.0	0.37	0.6	0.8	1.0	0.9	0.7	0.5	0.7	37.1	0.21	13	0.21	13
3132	U/S	Kuqa	Yaha	19-Sep-93	7.1	m	123.0	0.94	26.0	0.80	1.1	1.0	0.6	0.9	0.9	1.2						
3133	Blood & U/S	Kuqa	Wuzun	06-Aug-93	7.2	f	122.0	0.90	24.0	1.10	1.1	1.1	1.0	0.9	1.1	1.1	1.9	29.9	0.21	5	0.21	5
3134	U/S	Kuqa	Qiman	27-Sep-92	8.0	f	112.5	0.77	19.0	0.79	0.9	1.0	0.8	1.0	0.9	1.0						
3135	U/S	Kuqa	Yaha	07-Jun-93	7.3	m	123.0	0.88	22.0	0.94	1.1	1.2	0.9	0.9	1.0	0.9						
3136	U/S	Kuqa	Yaha	08-Sep-92	8.1	f	130.0	1.01	28.0	0.51	1.1	0.8	0.5	0.8	0.9	0.9						
3138	U/S	Kuqa	Qiman	06-Sep-92	8.1	m	123.5	0.89	23.0	1.19	1.1	0.9	1.0	0.7	1.4	1.5						
3139	U/S	Kuqa	Qiman	08-Feb-92	8.7	f	132.5	1.05	30.0	1.23	1.2	1.2	0.8	1.1	1.3	1.0						
3140	U/S	Kuqa	Yaha	05-Apr-93	7.5	f	132.0	1.00	27.0	1.16	1.2	1.1	0.9	0.9	1.5	0.8						
3141	U/S	Kuqa	Qiman	30-Sep-92	8.0	f	117.5	0.80	19.0	0.52	1.1	0.6	0.7	0.8	0.9	0.8						
3142	U/S	Kuqa	Yaha	13-Sep-92	8.1	f	127.0	0.99	28.0	0.74	1.1	1.1	0.7	0.7	1.0	1.0						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3143	U/S	Kuqa	Wuzun	14-Sep-92	8.1	f	121.0	0.85	21.0	0.82	0.8	0.9	1.0	1.2	0.8	1.0						
3144	U/S	Kuqa	Yaha	18-Jan-92	8.7	m	114.0	0.80	20.0	0.30	0.9	0.6	0.6	0.5	0.7	0.8						
3145	U/S	Kuqa	Yaha	25-Jun-93	7.3	f	122.0	0.89	23.0	0.50	0.9	0.7	1.0	1.0	0.7	0.6						
3146	U/S	Kuqa	Qiman	19-Oct-92	8.0	f	118.5	0.84	21.0	0.73	1.1	0.9	0.8	0.6	1.0	1.2						
3147	U/S	Kuqa	Qiman	04-Oct-91	9.0	f	123.0	0.91	24.0	1.42	1.5	1.5	0.8	0.9	1.0	1.3						
3148	U/S	Kuqa	Qiman	28-Sep-92	8.0	f	117.0	0.77	17.5	0.42	0.9	0.8	0.6	0.9	0.7	0.7						
3149	U/S	Kuqa	Yaha	18-Sep-93	7.1	m	123.0	0.91	24.0	0.42	0.8	0.9	0.7	0.9	0.7	0.6						
3150	U/S	Kuqa	Yaha	07-May-93	7.4	m	130.0	0.99	27.0	0.57	1.0	1.0	0.7	0.7	0.8	0.9						
3151	Blood & U/S	Kuqa	Yaha	25-Sep-92	8.0	m	130.0	1.01	28.0	0.48	0.7	0.7	0.9	0.9	0.8	0.8	0.7	55.9	0.52	345	0.52	345
3152	U/S	Kuqa	Yaha	06-Feb-93	7.7	f	125.0	0.89	22.0	0.52	0.9	0.8	0.7	0.9	0.8	0.8						
3153	U/S	Kuqa	Wuzun	14-Oct-92	8.0	f	116.0	0.82	21.0	0.69	0.9	0.8	0.8	1.1	0.9	0.9						
3154	U/S	Kuqa	Qiman	09-Feb-93	7.7	f	115.0	0.78	19.0	0.67	1.0	0.7	0.7	1.1	0.9	1.0						
3155	Blood & U/S	Kuqa	Wuzun	10-Apr-93	7.5	f	117.0	0.81	20.0	0.76	1.1	1.0	0.9	1.0	0.8	0.8	0.1	35.1	0.13	33	0.13	33
3156	U/S	Kuqa	Yaha	16-Apr-93	7.5	m	128.0	0.95	25.0	0.75	1.2	0.9	0.7	0.8	1.1	0.9						
3157	U/S	Kuqa	Yaha	08-Sep-92	8.1	f	132.0	0.99	26.0	0.78	0.9	1.0	0.9	0.9	1.0	0.9						
3158	U/S	Kuqa	Wuzun	14-Dec-92	7.8	f	119.0	0.87	23.0	0.71	0.9	0.9	0.8	1.0	0.8	1.0						
3159	Blood & U/S	Kuqa	Yaha	19-Mar-93	7.6	f	121.0	0.86	22.0	1.10	1.1	0.9	1.0	1.2	1.1	1.0	0.4	35.8	0.62	65	0.62	65
3160	U/S	Kuqa	Yaha	17-Sep-93	7.1	f	126.0	0.89	22.0	0.69	0.8	0.8	0.6	1.2	0.8	1.1						
3161	U/S	Kuqa	Wuzun	05-Nov-92	7.9	f	126.0	0.89	22.0	0.36	0.7	0.6	0.9	0.9	0.6	0.7						
3162	U/S	Kuqa	Wuzun	12-Apr-93	7.5	m	117.0	0.79	19.0	0.71	1.1	1.0	1.1	0.9	0.7	0.7						
3163	U/S	Kuqa	Yaha	08-Jul-93	7.3	m	126.0	0.92	24.0	0.96	1.0	1.0	1.0	1.0	1.0	1.0						
3164	U/S	Kuqa	Qiman	26-Sep-92	8.0	f	125.0	0.93	25.0	0.49	0.8	0.8	0.8	0.8	0.8	0.8						
3165	U/S	Kuqa	Yaha	07-Sep-92	8.1	m	125.0	0.89	22.0	1.49	1.9	1.1	1.0	1.1	1.0	1.0						
3166	U/S	Kuqa	Yaha	01-Dec-92	7.9	m	127.0	0.93	24.0	0.57	1.1	0.7	0.7	0.9	0.9	0.8						
3167	Blood & U/S	Kuqa	Yaha	17-Mar-92	8.6	m	123.0	0.91	24.0	0.32	0.6	0.7	0.9	1.0	0.6	0.5	2.8	31.9	0.19	65	0.19	65
3168	U/S	Kuqa	Qiman	09-Nov-91	8.9	m	133.5	1.03	28.0	0.71	1.2	0.9	0.7	0.9	0.9	0.9						
3169	U/S	Kuqa	Yaha	15-Sep-93	7.1	f	122.0	0.87	22.0	0.73	1.1	1.2	0.5	0.7	1.1	1.1						
3170	U/S	Kuqa	Qiman	02-Sep-92	8.1	f	125.0	0.93	25.0	1.26	1.2	1.0	1.0	1.2	1.0	1.2						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3172	U/S	Kuqa	Yaha	26-Sep-92	8.0	m	128.0	0.97	26.0	0.61	1.1	0.9	0.8	0.9	0.8	0.7						
3173	U/S	Kuqa	Qiman	04-Apr-93	7.5	m	130.0	0.96	25.0	1.17	1.3	1.2	0.7	0.8	1.1	1.5						
3174	U/S	Kuqa	Yaha	07-Sep-93	7.1	f	122.0	0.87	22.0	0.51	1.0	0.7	0.7	0.9	0.9	0.7						
3175	U/S	Kuqa	Yaha	22-Oct-93	7.0	f	123.0	0.86	21.0	0.42	0.8	0.8	0.8	0.9	0.7	0.6						
3176	U/S	Kuqa	Qiman	29-Oct-92	8.0	m	120.0	0.86	22.0	0.62	1.1	0.6	0.8	1.1	0.8	0.9						
3177	U/S	Kuqa	Wuzun	14-Aug-93	7.2	f	120.0	0.89	24.0	1.64	1.1	1.1	1.2	1.2	1.3	1.3						
3178	U/S	Kuqa	Yaha	05-Oct-91	9.0	m	130.0	0.96	25.0	0.61	1.0	1.0	0.7	0.8	0.9	0.8						
3179	U/S	Kuqa	Yaha	07-Apr-93	7.5	f	126.0	0.91	23.0	0.93	1.1	0.9	0.8	1.2	1.1	0.9						
3180	Blood & U/S	Kuqa	Yaha	17-Sep-92	8.1	f	130.0	0.93	23.0	1.11	1.0	1.0	1.1	1.1	1.0	1.1	2.9	57.2	0.38	20	0.38	20
3181	U/S	Kuqa	Yaha	07-Dec-93	6.8	f	118.0	0.83	21.0	0.28	0.7	0.5	0.7	1.0	0.6	0.6						
3182	U/S	Kuqa	Qiman	07-Dec-91	8.8	f	117.5	0.81	20.0	1.74	1.4	0.9	1.7	0.8	1.1	1.4						
3183	U/S	Kuqa	Wuzun	04-Aug-93	7.2	m	122.0	0.89	23.0	0.95	1.1	1.1	1.0	1.0	0.9	0.9						
3184	U/S	Kuqa	Wuzun	13-Jun-92	8.3	f	128.0	0.95	25.0	1.51	1.3	1.3	1.1	1.0	1.3	1.0						
3185	U/S	Kuqa	Qiman	07-Oct-92	8.0	f	123.0	0.91	24.0	0.79	0.9	0.9	0.7	1.1	0.9	1.1						
3186	U/S	Kuqa	Yaha	04-Jul-93	7.3	f	128.0	0.98	27.0	0.46	1.0	0.9	0.6	1.1	0.6	0.6						
3187	U/S	Kuqa	Yaha	07-Nov-93	6.9	m	129.0	0.97	26.0	0.50	1.0	0.9	0.6	0.7	1.0	0.7						
3188	U/S	Kuqa	Yaha	09-Nov-91	8.9	m	126.0	0.94	25.0	1.35	1.1	1.1	1.0	1.3	1.0	1.2						
3189	U/S	Kuqa	Yaha	06-May-93	7.4	f	126.0	0.89	22.0	0.72	0.9	0.9	1.1	1.0	0.8	0.8						
3190	U/S	Kuqa	Yaha	07-Nov-92	7.9	f	129.0	0.96	25.0	0.81	0.9	1.0	1.1	1.0	0.9	0.8						
3191	U/S	Kuqa	Yaha	23-Sep-93	7.0	m	117.0	0.83	21.0	0.45	0.7	0.8	0.9	1.0	0.6	0.7						
3192	U/S	Kuqa	Wuzun	15-Jan-94	6.7	f	122.0	0.87	22.0	0.78	0.9	1.0	0.9	1.0	0.9	0.9						
3193	U/S	Kuqa	Yaha	08-Mar-92	8.6	m	128.0	0.92	23.0	0.62	0.9	0.8	0.7	0.9	0.9	1.0						
3194	U/S	Kuqa	Yaha	07-Oct-92	8.0	f	123.0	0.91	24.0	0.53	0.9	0.7	1.1	1.2	0.6	0.6						
3195	U/S	Kuqa	Yaha	01-Dec-93	6.9	m	121.0	0.85	21.0	0.68	1.1	0.9	0.9	1.0	0.8	0.7						
3196	U/S	Kuqa	Yaha	09-Mar-92	8.6	f	132.0	0.99	26.0	0.78	0.9	0.9	0.9	1.2	0.8	0.9						
3197	U/S	Kuqa	Yaha	05-Dec-93	6.8	m	125.0	0.90	23.0	0.56	0.8	0.8	0.9	0.8	0.9	0.8						
3198	U/S	Kuqa	Yaha	17-Sep-93	7.1	m	118.0	0.87	23.0	0.61	0.8	0.8	1.1	1.0	0.8	0.7						
3199	U/S	Kuqa	Yaha	07-Dec-93	6.8	f	125.0	0.92	24.0	0.54	0.9	0.8	0.9	1.0	0.7	0.7						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3200	U/S	Kuqa	Yaha	08-Sep-92	8.1	m	133.0	0.98	25.0	0.86	1.2	1.1	0.6	0.7	1.2	1.2						
3201	U/S	Kuqa	Wuzun	18-Oct-92	8.0	m	118.0	0.82	20.0	0.52	0.9	0.9	0.8	0.8	0.8	0.7						
3202	U/S	Kuqa	Waqiao	09-Jun-91	9.3	m	130.0	0.97	25.5	1.09	0.9	1.0	1.2	1.2	1.0	1.0						
3203	Blood & U/S	Kuqa	Wuzun	06-Apr-93	7.5	m	122.0	0.89	23.0	0.75	1.1	0.8	0.9	1.2	0.8	0.8	1.4	34.5	0.48	85	0.48	85
3204	U/S	Kuqa	Wuzun	20-Apr-92	8.5	f	124.0	0.90	23.0	1.70	1.4	1.3	0.9	1.2	1.2	1.3						
3205	U/S	Kuqa	Wuzun	27-Mar-92	8.5	f	128.0	0.95	25.0	0.63	1.1	0.8	0.6	0.9	1.0	0.9						
3206	U/S	Kuqa	Wuzun	15-Jul-92	8.2	f	125.0	0.90	23.0	0.77	1.0	0.8	0.9	1.1	1.0	0.8						
3207	U/S	Kuqa	Waqiao	07-Sep-91	9.1	f	123.0	0.88	22.0	0.81	0.8	0.9	0.9	0.6	1.3	1.4						
3208	U/S	Kuqa	Waqiao	10-May-91	9.4	m	131.0	1.00	27.0	0.65	0.9	0.8	0.9	1.1	0.8	0.8						
3209	U/S	Kuqa	Waqiao	14-Jan-94	6.7	f	118.0	0.80	19.0	0.47	0.9	0.9	0.6	0.9	0.6	0.8						
3210	U/S	Kuqa	Waqiao	28-Jul-90	10.2	f	128.0	1.07	33.0	0.65	1.0	1.0	0.8	0.7	0.9	0.9						
3211	U/S	Kuqa	Wuzun	05-Dec-92	7.8	f	113.0	0.79	20.0	0.67	1.3	1.2	0.5	0.7	1.0	0.9						
3212	U/S	Kuqa	Waqiao	17-Jan-89	11.7	f	138.0	1.12	32.0	1.57	1.5	1.7	1.0	0.8	1.1	1.2						
3213	Blood & U/S	Kuqa	Waqiao	17-Jan-89	11.7	m	133.0	1.04	29.0	0.70	0.8	0.9	1.0	1.1	0.7	0.9	1.5	55.3	0.28	417/423	0.28	420
3214	U/S	Kuqa	Waqiao	05-Sep-91	9.1	f	119.0	0.84	21.0	0.84	1.1	1.1	0.8	0.8	1.0	1.0						
3215	U/S	Kuqa	Wuzun	17-Apr-92	8.5	f	113.0	0.76	18.0	0.98	1.1	1.2	0.9	0.8	1.1	1.0						
3216	U/S	Kuqa	Waqiao	28-May-90	10.4	f	138.0	1.02	26.0	1.04	1.1	1.1	1.1	1.1	1.0	0.8						
3217	U/S	Kuqa	Wuzun	17-Oct-91	9.0	f	127.0	0.90	22.0	1.15	1.1	1.0	1.0	1.0	1.1	1.2						
3218	U/S	Kuqa	Waqiao	11-Oct-91	9.0	f	123.0	0.89	23.0	0.72	1.1	1.1	0.8	0.8	0.8	0.9						
3219	U/S	Kuqa	Wuzun	29-Nov-91	8.9	m	128.0	1.01	29.0	0.77	1.0	0.9	0.8	1.0	1.0	0.9						
3220	U/S	Kuqa	Waqiao	09-Sep-90	10.1	m	124.0	0.90	23.0	0.98	1.3	1.0	0.8	1.0	1.0	1.0						
3221	U/S	Kuqa	Wuzun	07-Aug-93	7.2	f	120.5	0.86	22.0	0.69	1.0	1.0	0.9	0.9	0.9	0.7						
3222	U/S	Kuqa	Wuzun	01-Aug-92	8.2	m	126.0	0.89	22.0	0.34	0.7	0.6	0.6	0.9	0.9	0.6						
3223	U/S	Kuqa	Wuzun	28-Sep-91	9.0	m	128.0	0.95	25.0	0.51	0.7	0.7	0.9	1.1	0.6	0.9						
3224	U/S	Kuqa	Waqiao	15-Oct-92	8.0	f	122.0	0.90	24.0	1.26	1.1	1.0	1.1	1.0	1.1	1.3						
3225	U/S	Kuqa	Wuzun	07-Nov-92	7.9	m	125.0	0.97	27.0	0.89	1.0	0.9	1.0	1.2	1.1	0.7						
3226	Blood & U/S	Kuqa	Waqiao	15-Sep-94	6.1	f	113.0	0.76	18.0	0.47	1.0	1.0	0.6	0.9	0.6	0.7	0.5	31.9	0.78	50	0.78	50
3227	U/S	Kuqa	Wuzun	05-Jul-92	8.3	f	124.0	0.95	26.0	0.90	1.3	0.8	0.7	1.0	1.1	1.1						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3228	U/S	Kuqa	Waqiao	11-May-92	8.4	f	123.0	0.91	24.0	0.53	1.0	1.0	0.6	0.8	0.9	0.7						
3229	Blood & U/S	Kuqa	Wuzun	05-Nov-92	7.9	m	116.0	0.82	21.0	0.71	1.0	0.9	0.7	0.8	1.0	1.1	1.4	43.6	0.24	15	0.24	15
3230	U/S	Kuqa	Waqiao	05-Nov-93	6.9	m	117.0	0.84	22.0	0.42	1.0	1.3	0.7	0.6	0.7	0.5						
3231	U/S	Kuqa	Waqiao	04-Feb-92	8.7	m	121.0	0.91	25.0	0.89	0.9	1.1	0.8	1.1	0.9	1.0						
3232	U/S	Kuqa	Waqiao	27-Mar-89	11.5	m	142.0	1.14	32.0	0.88	0.9	1.1	1.2	1.1	0.8	0.8						
3233	Blood & U/S	Kuqa	Waqiao	03-Jun-89	11.4	f	132.0	1.05	30.0	0.68	0.9	0.8	0.7	0.9	1.0	1.1	0.7	24.1	0.40	110	0.40	110
3234	U/S	Kuqa	Wuzun	20-Sep-91	9.1	m	116.0	0.82	21.0	1.28	1.1	1.2	1.0	1.1	1.1	1.1						
3235	U/S	Kuqa	Wuzun	04-May-92	8.4	f	122.0	0.85	21.0	0.44	0.9	1.0	0.6	0.7	0.8	0.7						
3236	U/S	Kuqa	Wuzun	01-May-92	8.4	m	125.0	0.90	23.0	0.59	0.9	0.7	1.0	0.9	0.8	0.8						
3237	Blood & U/S	Kuqa	Waqiao	28-Jan-94	6.7	f	117.0	0.76	17.0	0.42	0.6	1.1	0.9	0.5	0.7	0.9	1.9	50.7	0.88	298	0.88	298
3238	U/S	Kuqa	Wuzun	07-Aug-93	7.2	f	122.0	0.87	22.0	0.60	1.2	0.8	0.7	0.9	0.9	0.7						
3239	U/S	Kuqa	Wuzun	05-Mar-92	8.6	m	122.0	0.87	22.0	1.21	1.1	1.3	0.8	1.0	1.1	1.2						
3240	U/S	Kuqa	Waqiao	10-May-91	9.4	f	131.0	0.93	23.0	0.63	0.9	0.8	1.1	1.1	0.8	0.6						
3241	U/S	Kuqa	Wuzun	14-Jul-93	7.2	f	128.0	0.92	23.0	0.45	1.1	0.9	0.6	0.6	1.0	0.5						
3242	U/S	Kuqa	Waqiao	06-Jan-94	6.8	f	113.0	0.76	18.0	0.55	0.9	0.9	0.7	0.8	0.9	0.8						
3243	U/S	Kuqa	Waqiao	06-Sep-90	10.1	m	135.0	1.11	33.0	2.18	1.4	1.5	1.0	1.4	1.3	1.3						
3244	U/S	Kuqa	Wuzun	09-Jan-92	8.8	m	132.0	0.99	26.0	0.70	0.9	1.0	0.8	1.2	0.7	0.8						
3245	U/S	Kuqa	Waqiao	20-Feb-92	8.6	f	118.0	0.83	21.0	0.69	0.9	1.0	0.8	0.9	1.0	0.8						
3246	U/S	Kuqa	Wuzun	14-Mar-93	7.6	m	119.0	0.87	23.0	1.19	1.0	1.1	1.3	1.2	0.9	1.0						
3247	U/S	Kuqa	Wuzun	18-Nov-91	8.9	m	115.0	0.80	20.0	0.58	0.9	0.8	0.7	0.9	0.9	0.9						
3248	U/S	Kuqa	Wuzun	27-Nov-91	8.9	m	125.0	0.90	23.0	1.86	1.4	1.2	1.2	1.3	1.2	1.2						
3249	U/S	Kuqa	Waqiao	13-May-89	11.4	f	131.0	1.00	27.0	0.62	0.8	0.9	0.9	1.0	0.8	0.8						
3250	U/S	Kuqa	Waqiao	08-Jan-89	11.8	m	146.0	1.29	41.0	0.92	1.3	1.0	1.0	1.1	0.8	0.8						
3251	U/S	Kuqa	Waqiao	15-Nov-91	8.9	m	122.0	0.90	24.0	1.29	1.2	1.2	0.9	0.9	1.2	1.3						
3252	U/S	Kuqa	Waqiao	04-Sep-93	7.1	m	116.0	0.81	20.0	0.73	1.0	1.0	0.8	0.8	0.9	1.0						
3253	U/S	Kuqa	Waqiao	29-Jan-91	9.7	m	131.0	0.97	25.0	0.61	0.8	1.0	1.0	0.8	0.8	0.8						
3254	Blood & U/S	Kuqa	Waqiao	15-Oct-92	8.0	m	116.0	0.84	22.0	0.55	0.9	0.8	0.8	1.0	0.7	0.8	2.3	50.1	0.64/0.67	240	0.66	240
3255	U/S	Kuqa	Waqiao	01-Jun-92	8.4	m	126.0	0.94	25.0	0.74	1.1	0.9	0.9	0.9	0.9	0.8						

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3256	U/S	Kuqa	Waqiao	04-Feb-90	10.7	f	129.0	0.94	24.0	0.70	1.1	1.0	0.6	0.8	1.0	1.0						
3257	U/S	Kuqa	Waqiao	15-Dec-90	9.8	m	132.0	1.02	28.0	0.74	1.3	1.0	0.7	0.9	0.9	0.8						
3258	U/S	Kuqa	Waqiao	10-Mar-92	8.6	f	122.5	0.89	23.0	0.45	0.8	0.6	1.0	0.8	0.7	0.8						
3259	U/S	Kuqa	Wuzun	14-Oct-91	9.0	m	125.0	0.90	23.0	0.78	0.9	0.7	0.8	1.0	1.1	1.2						
3260	U/S	Kuqa	Waqiao	11-Oct-89	11.0	f	140.0	1.05	27.0	0.58	0.7	0.8	1.0	0.8	1.0	0.8						
3261	U/S	Kuqa	Waqiao	27-Sep-91	9.0	m	128.5	0.89	21.0	0.71	1.1	1.0	0.6	0.7	1.2	1.0						
3262	Blood & U/S	Kuqa	Waqiao	19-Feb-89	11.6	f	140.0	1.13	32.0	0.73	0.8	0.8	0.9	1.1	0.9	1.0	4.9	35.8	1.20	680	1.20	680
3263	U/S	Kuqa	Waqiao	10-Mar-90	10.6	m	132.5	0.98	25.0	0.91	1.0	0.9	1.0	1.1	0.9	1.0						
3264	Blood & U/S	Kuqa	Wuzun	10-Nov-92	7.9	m	123.0	0.89	23.0	0.74	0.9	0.8	1.0	0.9	1.0	0.9	3.6	50.7	0.45	65	0.45	65
3265	U/S	Kuqa	Waqiao	07-Sep-93	7.1	m	113.0	0.76	18.0	0.71	1.2	0.8	0.7	0.9	1.0	0.9						
3266	U/S	Kuqa	Waqiao	02-Oct-90	10.0	m	122.0	0.89	23.0	1.03	1.1	0.9	1.1	1.2	0.8	1.1						
3267	U/S	Kuqa	Waqiao	14-Jul-89	11.2	m	126.0	1.00	29.0	1.09	1.2	1.2	0.8	1.1	1.0	1.0						
3268	Blood & U/S	Kuqa	Waqiao	05-Jul-92	8.3	f	128.0	0.97	26.0	1.01	1.2	1.2	0.8	0.8	1.1	1.1	0.8	45.5	2.85	75	2.85	75
3269	U/S	Kuqa	Waqiao	05-Jun-91	9.4	f	126.0	0.96	26.0	0.40	1.0	0.7	0.7	1.0	0.6	0.6						
3270	U/S	Kuqa	Wuzun	19-Mar-92	8.6	m	123.0	0.95	27.0	0.62	1.0	0.9	0.6	0.7	1.1	1.0						
3271	U/S	Kuqa	Wuzun	12-Oct-92	8.0	f	122.0	0.84	20.0	0.87	1.0	1.0	0.8	1.1	0.9	1.0						
3272	U/S	Kuqa	Wuzun	30-Nov-91	8.9	m	131.0	1.03	29.0	1.86	1.4	1.3	1.1	1.3	1.2	1.2						
3273	U/S	Kuqa	Wuzun	14-Apr-92	8.5	f	117.0	0.83	21.0	0.92	1.0	1.2	0.7	1.0	1.2	0.9						
3274	U/S	Kuqa	Waqiao	02-Jul-91	9.3	f	128.0	0.95	25.0	1.08	1.2	1.3	0.9	1.0	1.0	0.9						
3275	U/S	Kuqa	Waqiao	28-May-90	10.4	f	135.0	nd	nd	0.86	1.1	0.9	0.9	0.9	1.0	1.0						
3276	U/S	Kuqa	Wuzun	07-Nov-92	7.9	m	114.0	0.83	22.0	1.00	1.1	1.1	0.9	1.1	1.0	0.9						
3277	U/S	Kuqa	Waqiao	20-Jul-92	8.2	f	121.0	0.88	23.0	0.68	0.8	0.7	1.2	1.2	0.7	0.9						
3278	Blood & U/S	Kuqa	Wuzun	10-May-93	7.4	m	123.0	0.88	22.0	1.24	1.3	0.9	0.9	1.2	1.2	1.1	2.6	28.6	0.56/0.59	63	0.58	63
3279	Blood & U/S	Kuqa	Waqiao	25-Oct-88	12.0	m	148.0	1.26	38.0	1.40	1.1	1.1	1.1	1.3	1.0	1.2	2.0	40.9	0.58	493	0.58	493
3280	U/S	Kuqa	Waqiao	16-Apr-92	8.5	f	127.0	0.93	24.0	0.95	1.2	1.1	0.7	0.8	1.1	1.2						
3281	U/S	Kuqa	Waqiao	29-Jul-92	8.2	m	120.0	0.86	22.0	1.21	1.0	1.1	1.2	1.2	1.0	1.0						
3282	U/S	Kuqa	Wuzun	05-Jul-92	8.3	m	124.0	0.88	22.0	1.20	1.9	1.1	1.0	0.9	0.9	0.8						
3283	U/S	Kuqa	Waqiao	08-Jul-92	8.3	m	116.5	nd	nd	1.03	1.1	1.1	0.8	0.9	1.1	1.2						

Sample Number	Sample Type	Area	Village	Date of Birth	Age	Sex	Height cm (minus 1 cm AC148)	Body Surface Area m^2 (minus 1 cm ht AC148)	Weight kg	Thyroid Volume mls	Th h/r cm	Th h/l cm	Th b/r cm	Th b/l cm	Th d/r cm	Th d/l cm	TSH mIU/l whole blood	T4 nmol/l whole blood	F Urine mg/l Raw	I Urine ug/l Raw	F Urine mg/l	I Urine ug/l
3284	Blood & U/S	Kuqa	Waqiao	02-Sep-89	11.1	f	137.0	1.05	28.0	0.89	1.2	1.0	0.7	1.0	0.9	1.1	0.6	42.3	0.62	35	0.62	35
3285	U/S	Kuqa	Wuzun	03-Sep-92	8.1	m	118.0	0.88	24.0	2.05	1.2	0.9	1.5	1.8	1.3	1.2						
3286	U/S	Kuqa	Wuzun	17-May-92	8.4	f	128.0	0.93	24.0	0.82	1.0	1.0	0.9	1.0	0.9	0.9						
3287	Blood & U/S	Kuqa	Waqiao	26-Mar-89	11.5	m	130.0	1.04	30.0	1.10	1.2	1.1	0.9	1.0	1.0	1.1	1.6	35.8	0.62	90	0.62	90
3288	U/S	Kuqa	Wuzun	17-Sep-90	10.1	m	141.0	1.10	30.0	1.00	0.8	1.0	1.1	1.1	1.0	1.1						
3289	Blood & U/S	Kuqa	Waqiao	02-Dec-91	8.9	m	122.0	0.87	22.0	0.62	1.1	0.9	0.8	1.1	0.8	0.6	0.0	30.6	0.91	15	0.91	15
3290	U/S	Kuqa	Waqiao	01-Sep-91	9.1	f	122.0	0.87	22.0	0.67	1.0	1.0	0.7	0.7	0.9	1.1						
3291	U/S	Kuqa	Waqiao	03-Jan-90	10.8	f	141.0	1.09	29.0	0.75	1.1	1.0	0.7	0.9	1.1	0.8						
3292	U/S	Kuqa	Waqiao	15-Nov-91	8.9	m	122.0	0.90	24.0	1.33	1.5	1.4	0.8	0.8	1.2	1.2						
3293	U/S	Kuqa	Wuzun	19-Oct-91	9.0	m	126.0	0.94	25.0	1.29	1.0	0.8	1.2	1.2	1.2	1.3						
3294	U/S	Kuqa	Waqiao	01-Jun-92	8.4	m	121.0	0.88	23.0	0.81	1.1	0.9	0.8	1.0	1.0	0.9						
3295	U/S	Kuqa	Waqiao	07-Aug-89	11.2	m	133.0	1.01	27.0	0.65	1.0	0.9	0.8	1.1	0.7	0.8						
3296	U/S	Kuqa	Wuzun	04-Dec-91	8.9	f	130.0	1.02	29.0	0.96	1.0	1.0	0.9	1.0	1.0	1.1						
3297	U/S	Kuqa	Waqiao	08-Feb-90	10.7	m	131.0	0.98	26.0	1.20	1.2	1.2	0.9	1.0	1.2	1.0						
3298	U/S	Kuqa	Waqiao	25-Mar-94	6.5	m	115.0	0.83	22.0	0.55	0.9	0.7	0.8	0.9	0.9	0.8						
3299	Blood & U/S	Kuqa	Waqiao	01-Jan-91	9.8	m	126.0	0.92	24.0	0.79	1.2	1.0	0.7	1.0	1.0	0.8	0.3	31.9	0.28	475	0.28	475
3300	U/S	Kuqa	Wuzun	04-Aug-92	8.2	m	131.0	0.95	24.0	1.04	1.2	1.1	1.0	1.0	0.9	1.0						
3305	U/S	Kuqa	Waqiao	27-Mar-91	9.5	f	121.0	0.91	25.0	0.87	1.1	1.2	0.7	0.8	1.0	1.1						
3383	U/S	Kuqa	Waqiao	21-Apr-91	9.5	f	120.5	0.85	21.0	0.34	0.9	0.8	0.5	0.7	0.7	0.7						

Th h/r = thyroid right-lobe height
Th b/r = thyroid right-lobe breadth
Th d/r = thyroid right-lobe depth
Th h/l = thyroid left-lobe height
Th b/l = thyroid left-lobe breadth
Th d/l = thyroid left-lobe depth
U/S = Ultrasound
nd = no data