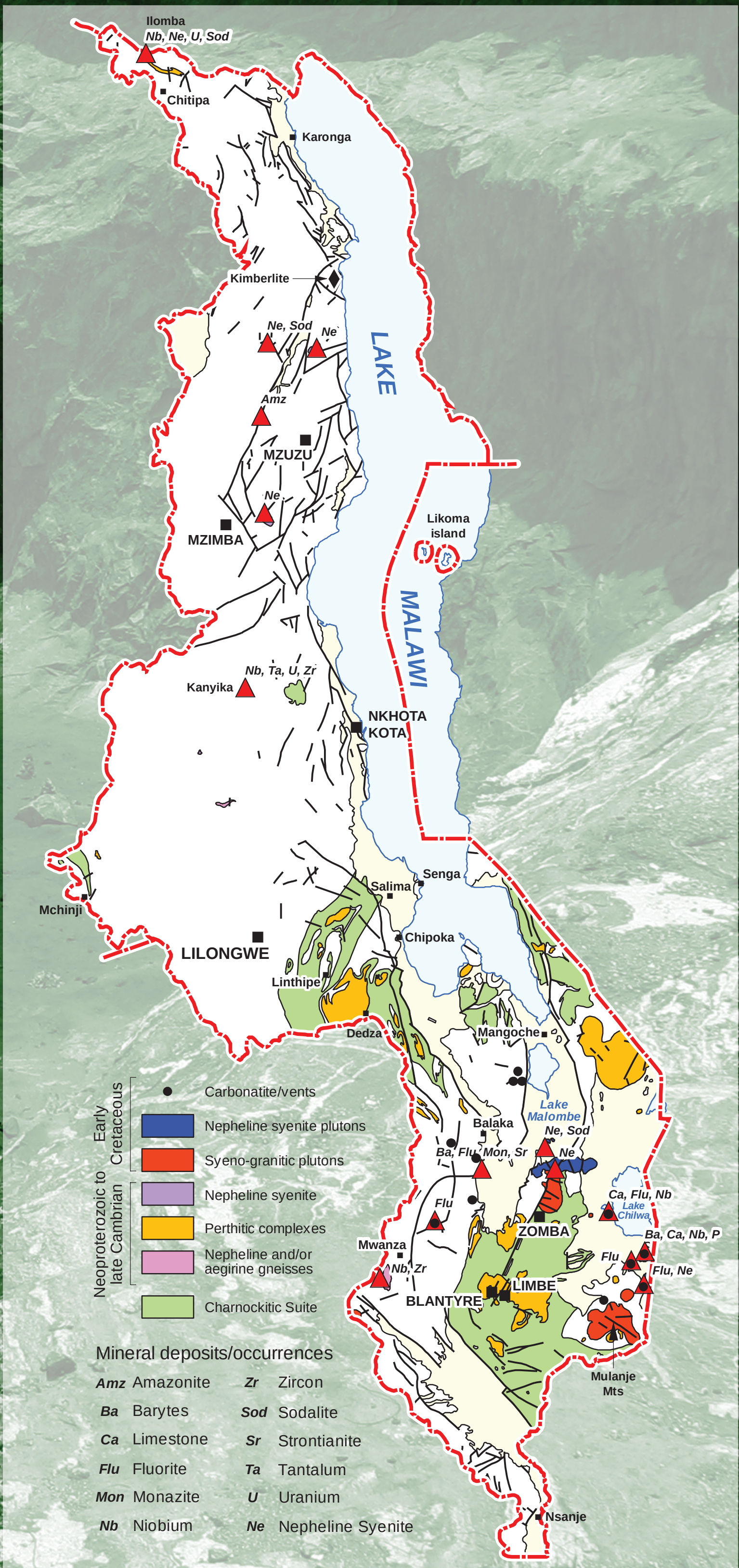
Ministry of Energy
and Mines
REPUBLIC OF MALAWI

Mineral potential of Malawi

1 Mineral deposits associated with alkaline magmatism (rare earth metals, coltan metals, nuclear metals, phosphate, etc.)

Produced for the Ministry of Energy and Mines of Malawi by the British Geological Survey under the auspices of the UK Department for International Development.



Courtesy of Globe Metals & Mining Ltd.

Alkaline magmatism

Alkaline magmatism in Malawi has occurred during the early phases of intracontinental rifting events with melt generation by mantle upwellings beneath thinned crust. Alkaline rocks are those in which the alkali content (Na_2O +K_2O) is more than can be taken up by the feldspars with the available silica resulting in the appearance of feldspathoids and/or alkali pyroxenes/amphiboles. Alkaline rock types range from felsic to ultramafic and are found in several associations characterised by distinctive rock types including carbonatites. Alkaline magmatic systems are important repositories of barite, fluorite, nepheline syenite, rare-earth metals, phosphate, niobium, tantalum, thorium, uranium and zirconium. They may also be sources of copper, titanium, strontium, vermiculite and lateritic nickel.

January 2009

Alkaline magmatic provinces and suites

Malawi comprises alkaline rocks of the Pan African cycle (pre- and post- Mozambiquan orogeny) and also of Early Cretaceous age that relate to the rifting of the Gondwana supercontinent. The East African Rift is a present day expression of a major crustal suture.

The **Neoproterozoic North Nyasa Alkaline Province** (NNAP) of central and northern Malawi consist of seven intrusions (Kasungu, Chipala, Chikangawa, Mphompha, Telelele Hill, Ilomba and Ulindi) that lie along a north-south trend roughly parallel to the current rift valley. The dominant lithology is nepheline syenite, but alkali syenite and granite occur at Mphompha and pyroxenites outcrop adjacent to, and within the Ilomba intrusion. Available data indicate that the NNAP plutons were emplaced at 750–710Ma and subsequently metamorphosed at c.450Ma during the Pan African event.

The Ilomba and Ulindi intrusions on the northern border with Tanzania occur within the northwest-trending Songwe Syenite which intruded gneisses of Ubendian age. Ilomba comprises a central mass of aegirine-nepheline microsyenite surrounded by an incomplete ring of locally sodalite-rich biotite-nepheline syenites and minor pyroxenites within coarse aegirine-bearing perthosites.

The **late Pan African alkaline ring complexes** of southern Malawi include Thambani, Bilila and the east-west line of Chingale, Mlindi, Little Michuru and Ntonya. They typically contain metapyroxenite cores with peripheries of syenite and hybrid rocks. In addition there is a swarm of biotitite bodies (the Majete group) that are considered to be metasomatised derivatives of intrusive ultramafic rocks. The Mlindi ring complex, dated at 495Ma, contains from the centre outward: pyroxenite, gabbronorite to syenogabbro, gabbro-diorite and syenite. The entire ring complex is cut by dykes and veins of pegmatite, microsyenite and lamprophyre. Nepheline is unknown and there is no association with carbonatite.

Deformed alkaline rocks and carbonatites may mark Proterozoic suture zones where oceans have opened and closed. This Neoproterozoic Rift belt has remained a zone of crustal weakness and a locus for alkaline magmatic activity during the Mesozoic.

The Early Cretaceous **Chilwa Alkaline Province** of southern Malawi has an exceptional range of lithologies from carbonatite to granite. It lies at the southern end of the East African rift and is unique for its essentially intrusive character. The largest plutons consist of syenite and peralkaline granite with smaller intrusions comprising syenite, nepheline syenite, sodalite syenite and carbonatite. Metamorphosed basanite/nephelinite volcanics are mainly preserved in down-faulted blocks. Extrusion of nephelinitic lavas and emplacement of nepheline and sodalite syenites at c.135Ma was followed by nepheline syenites and syenites at c.126Ma and large syenite-peralkaline granite plutons at c.113Ma.

Chilwa Island is a multiple carbonatite complex composed of sideritic carbonatite, ankeritic sövite and sövite. An arcuate body of feldspathic breccia surrounds much of the complex and separates the main carbonatite phases from the outer zone of fenitized gneisses. The carbonatites have been intruded by ring dykes of nepheline syenite and ijolite and dykes and plugs of alnöite, camptonite, trachyte, nephelinite and phonolite.

Junguni is essentially composed of coarse-grained sodalite-nepheline±cancrinite syenite. It is the most strongly silica-undersaturated peralkaline pluton in the province.

The overlapping intrusions of Chikala, Chaone, Mongolowe and Chinduzi were emplaced along an east-west line. The probable sequence of emplacement is syenite - nepheline-bearing alkali feldspar syenite – nepheline syenite. The plutons become more silica-undersaturated towards the west with an increase in the relative abundance of nepheline-rich rocks and the appearance of sodalite.

Zomba-Malosa consists of a central plug of syenite, an inner ring of quartz microsyenite and outer ring of peralkaline granite. Malosa consists of a heterogeneous mixture of quartz syenite and granite. The western side of the pluton is cut by a rift valley fault with downthrow to the west of >1000m.

Cretaceous intrusive activity in the northern part of the country includes kimberlitic breccias, dolerite dykes, diorite and pyroxenite intrusions.

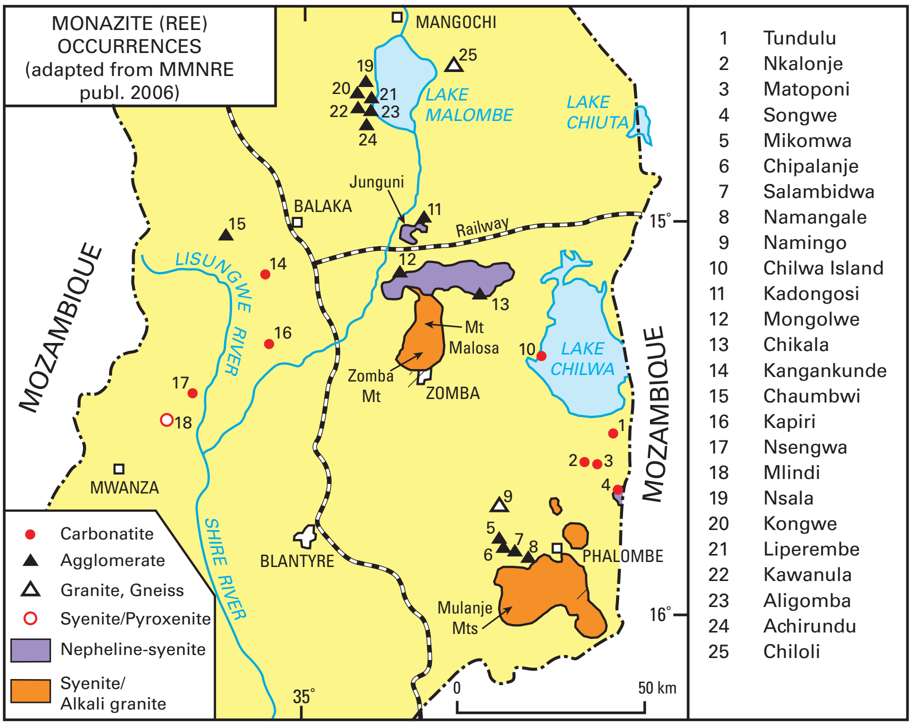
Rare Earth Metals

Rare Earth Metals include the lathanides, scandium and yttrium. They are mainly used as catalysts in oil refining, catalytic converters, the glass industry, colouring agents, fibre optics, camera lenses, TV tubes, Sm-Co permanent magnets, high strength alloys and synthetic minerals for laser applications. The main economic minerals are bastnaesite and monazite.

Monazite occurrences are widespread throughout the Chilwa Alkaline Province and locally form residual concentrations in heavy mineral sands (see brochure 4).

View of Kangankunde Hill.

EAST AFRICAN CARBONATITES — intrusive carbonate-mineral-rich igneous rocks	
Rock types	Calcite-carbonatite or sövite (calciocarbonatite) e.g Chilwa Island
	Dolomite-carbonatite or beforsite (magnesiocarbonatite)
	Ferroan-or ankeritic-carbonatite (ferrocarbonatite) e.g Kangankunde
	Natrocarbonatite — Na, K and Ca carbonates - not known in Malawi
Tectonic environment	Spatially related to faults within rifted or incipiently rifted continental plates; associated with alkaline volcanic activity
Morphology	Ring complexes, plugs, cone sheets, dykes and vent agglomerates
Associated rock types	Nepheline syenite, pyroxenite, ijolite, melteigite, phonolite and more rarely mica peridotite; halo of fenitization (alkali metasomatism)
Deposit types	Banded metasomatic replacements, disseminations, breccia zones, dykes, sills and irregular masses — commonly multi-stage
Ore types	Apatite-magnetite type: apatite±pyrochlore±columbite±perovskite
	RE-type: monazite±bastnaesite±baryte±strontianite±rhodochrosite
	General: calcite/dolomite±fluorite±sulphides±Ti minerals±zircon
Trace element geochemistry	Enriched in F,Th, U, Ti, Zn, Nb, Y, Mo, Cu, V, P, Mn, S, La, Ce, Sm, Eu, Pb, Zr & Ba



Monazite occurrences in the Chilwa Alkaline Province.

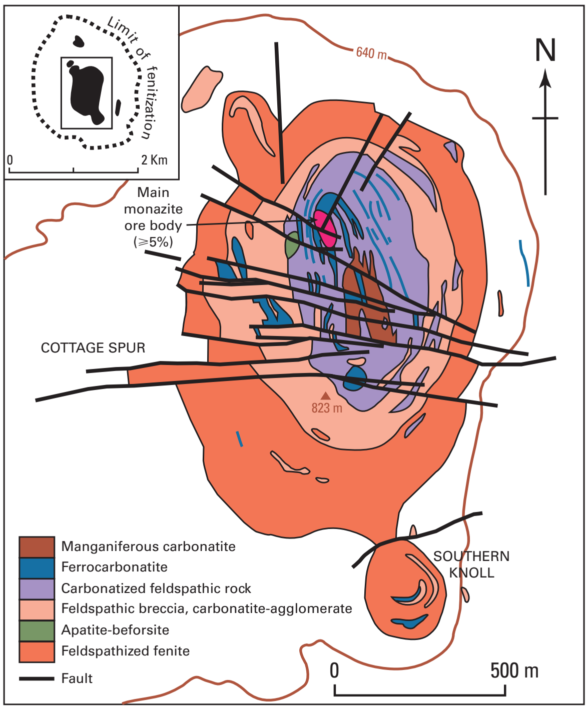
The Kangankunde Complex of the Lower Cretaceous Chilwa Alkaline Province consists of roughly concentric zones of agglomerate, breccia, feldspathoid gneisses and fenites surrounding a core of ankeritic and sideritic carbonatite with monazite, strontianite and disseminated manganese oxides. It differs from all the other large carbonatitic centres in Malawi both in the lack of sövite and the abundance instead of strontianite-rich ankeritic carbonatites and also in the virtual absence of associated silicate intrusions bar a few minor dykes and plugs of alnoite and carbonatised nephelinite. Kangankunde is also unusual for the large scale replacement of feldspathised fenite and agglomerate by carbonates and the high concentrations of REE phosphate minerals. There are no zones of pyrochlore enrichment. It is apparently at a higher erosion level than the Tundulu and Chilwa Island Complexes. The monazite is reknowned for its high Ce content and extremely low thorium and uranium levels. The deposit has an inferred resource of 107,000t of rare-earth oxide (REO) at an average grade of 4.24% REO using a 3.5% REO cut-off grade and remains open at depth. Testwork shows that the deposit is amenable to low-cost gravity separation producing a 60% REO concentrate.

The Tundulu Complex contains large quantities of REE minerals, mainly bastnaesite, in addition to substantial reserves of apatite. The rocks of Nathache Hill are estimated to contain >3,225,000 tonnes at 2.4% REO per 30 metre depth.

Strontianite (a source of strontium) would be recovered as a by-product of any monazite exploitation at Kangankunde. Indicated reserves are 11Mt at 8% Sr. Strontium is used in glass manufacture, in ferrite ceramic magnets, pyrotechnics, chemicals, etc.

Coltan metals, uranium and zirconium

The coltan metals, niobium (Nb) and tantalum (Ta) have similar properties. Niobium is mainly used in specialist steels, superconductors and in nuclear reactors. The main use of tantalum is in capacitors for laptop computers, mobile phones and digital cameras. It is also used in superalloys and for surgical instruments. The principal use of uranium and zirconium is in commercial nuclear power generation. Pyrochlore is the main source of niobium.



Map of the Kangankunde carbonatite. (Geology by M S Garson, 1963; orebody from Holt, 1965).

Nb-Ta-U pyrochlore and zircon mineralisation is typically associated with nephelinitic and carbonatite intrusives either as primary magmatic or replacement deposits (intra-intrusive veins or stringer zones, extra-intrusive fenites or veins). The residual weathering accumulations from either deposit type may also be economic (see Brochure 4).

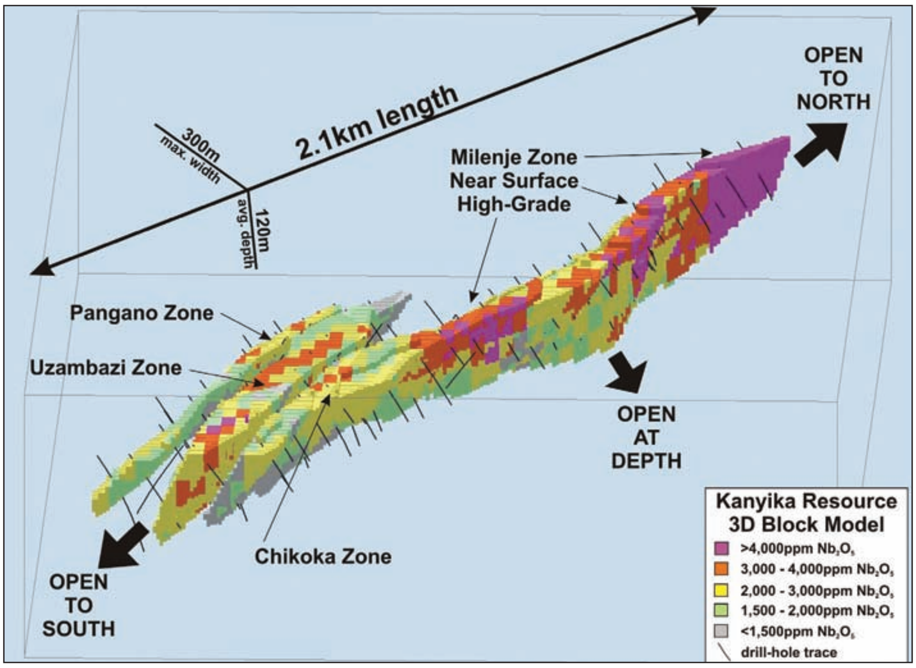
The Ilomba Hill Alkaline Complex in the far northwest of the country was investigated by surface trenching in the 1950s and returned analyses of up to 2.15% U_3O_8 and 7.50% Nb_2O_5 associated with uraniferous pyrochlore. The total resource amounts to 0.1 Mt of Nb_2O_5 at a grade of 0.3% Nb_2O_5. Titanites and eudialytes contain up to 11% Nb_2O_5 and >3.5% Nb_2O_5 respectively which reflects a high Nb activity in the primary melt. The high Nb/Ta ratios are more typical of carbonatites and the nearby presence of the Nachendezwaya carbonatite complex in Tanzania suggests a linkage between these intrusions.

Globe Metals and Mining Ltd. is undertaking a pre-feasibility study of its Kanyika multi-commodity (Nb, U, Ta, Zr) deposit, 55 km NE of Kasungu in Central Malawi. The Kanyika mineralisation is hosted in a N–S striking intrusive body of nepheline syenite emplaced in basement gneisses that is coincident with a strong airborne radiometric anomaly. The host mineralised alkaline igneous rock has an overall dip of 45–80° to the west, is over 3.5 km long and up to 300 m in width. High-grade ore zones occur immediately adjacent and parallel to the footwall and hangingwall in the central and northern Milenje zone. The inferred Joint Ore Reserves Committee (JORC) resource, defined over 2.1 km strike length, and to an average vertical depth of 120 m is 56.4 Mt at 0.26% Nb_2O_5 (145,500 t), 0.007% U_3O_8 (4000 t), 0.012% Ta_2O_5 (6,600 t) and 0.48% $ZrSiO_4$ (272,400 t) based upon a 0.15% Nb_2O_5 cut-off.

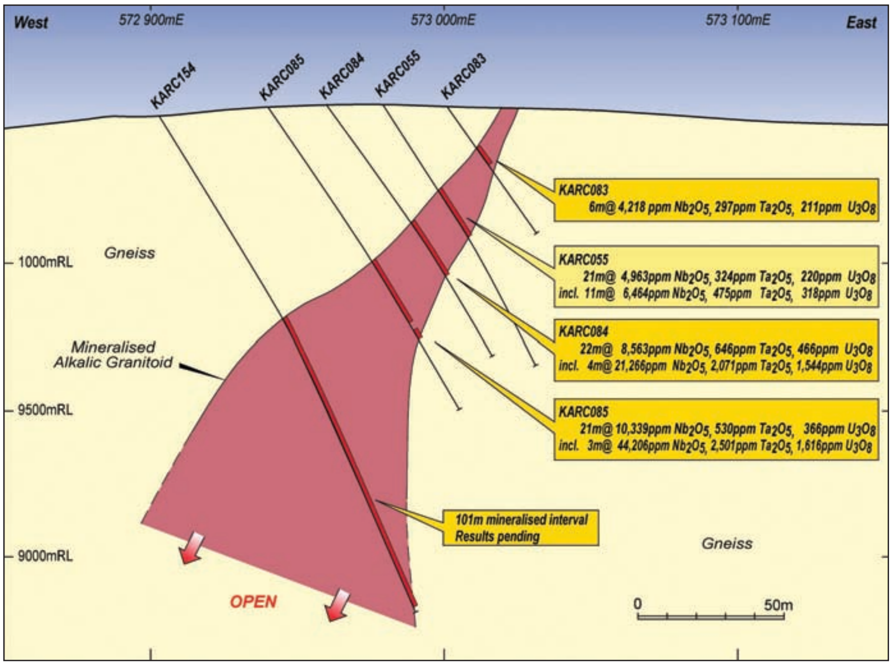
Current exploration is focussing on the Milenje zone which is the northern extension of the footwall Chikoka zone further south. Within the broad westerly-dipping high-grade marginal parts of the mineralised intrusion the ore is locally controlled by sub-vertical, S_2 foliation-parallel pyrochlore and zircon-rich pegmatitic segregations and veins. These form en echelon arrays which obliquely transect the concordant foliated syenite. Pyrochlore is the dominant ore mineral which contains most of the niobium, tantalum and uranium. It is disseminated throughout the high-grade zones with no apparent diminishment in tenor with depth (max.300 m). The U content of the zircon is 400-800 ppm whereas it can reach up to 10% in the pyrochlore.

Initial results of 7500m of infill RC and diamond core drilling indicate that the northern Milenje Zone contains a near-surface high grade zone of 14.1 Mt with >1% Nb_2O_5 (52,500t) over more than 200 metres strike length within a broader 1.2 km zone. The cut-off is 0.30% Nb_2O_5. Results published in the last quarter of 2008 include 21 m @ 1.03% Nb_2O_5, 0.053% Ta_2O_5, 0.037% U_3O_8 and 17 m @ 1.403% Nb_2O_5, 0.085% Ta_2O_5, 0.059% U_3O_8 including 5 m @ 2.198% Nb_2O_5, 0.100% Ta_2O_5, 0.078% U_3O_8. This near-surface component could be mined by open pit with a low strip ratio of 0.5–0.9 for the first 6+ years of operations which will provide early payback of the capital expenditure. It is intended to produce separate pyrochlore and zircon concentrates. Initial testwork achieved c.72% recovery but the company is confident that this can be improved.

The Kanyika project, along with a number of other Exclusive Prospecting Licence (EPL) blocks held by other Minex companies in search of U-Nb-Ta mineralisation associated with intrusives in the Basement Complex (Oropa Exploration Pty Ltd. at Chinzani, Chitunde & Mzimba; Mantra Resources Ltd. at Chikangawa, Chintheche & Nanzeka) was first identified from reprocessing the country-wide airborne radiometric and magnetic survey data acquired in 1984/85 by Hunting Geology and Geophysics Ltd.



3D block diagram of the Kanyika ore zone. (Reproduced with permission of Globe Metals & Mining Ltd.)



Cross-section through the Milenje Zone (7150 mN). Reproduced with permission of Globe Metals & Mining Ltd.

Many of the target radiometric anomalies are circular but the deposit model and search parameters developed by Globe indicate that other geometries/intrusive morphologies may be prospective.

Some of the mineralised carbonatites have significant amounts of pyrochlore which could be extracted as a by-product. Pyrochlore-rich carbonatite at Chilwa Island has indicated reserves of 375,000 t at 0.95% Nb_2O_5 whilst the Tundulu carbonatite hosts estimated reserves of 900,000 t at 0.37% Nb_2O_5.


Courtesy of Globe Metals & Mining Ltd.

Drill core with pyrochlore mineralisation. (Reddish-brown mineral), Kanyika deposit.

Phosphate (apatite)

Phosphate rock is an essential raw material for the manufacture of compound phosphate fertilisers, mostly by acidulation. Ground or simply processed phosphate rock can also be an effective and appropriate fertiliser when applied under specific soil and climatic conditions for certain crops. Compaction or blending ground phosphate with chemical fertilisers may also be a cost-effective method of providing both short and long-term plant nutrients.

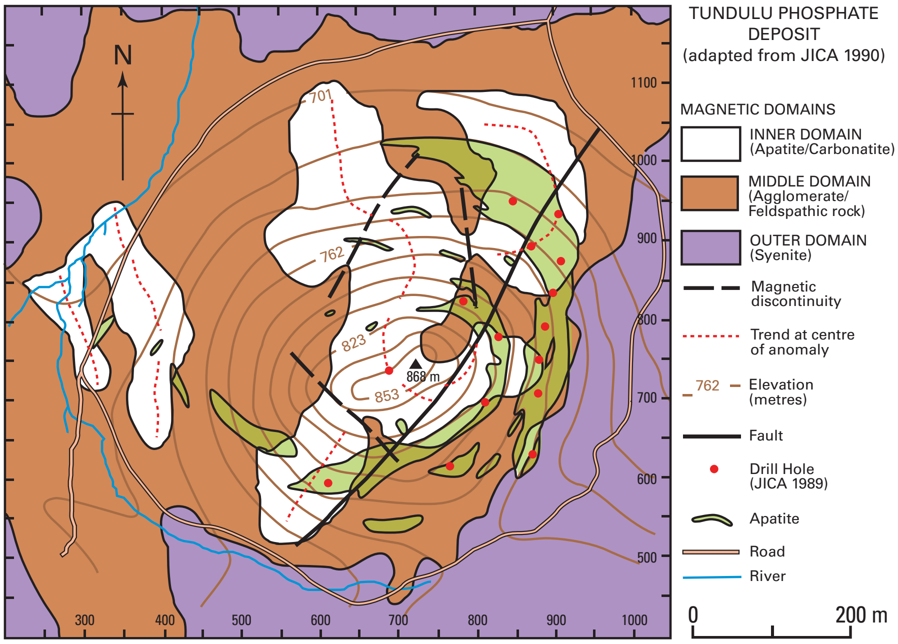
The Tundulu, Chilwa Island and Kangankunde carbonatite complexes in southern Malawi all contain hard rock phosphate concentrations in the form of apatite. Of these, only the apatite rock at Tundulu in the Mulanje district has any economic potential as a fertiliser raw material.

The Tundulu Ring Complex rises steeply out of the surrounding Phalombe plain to an altitude of 967 m and comprises three igneous centres. Centre 1 comprises a circular aureole of fenitization about a 2 km diameter plug of syenite. The second carbonatite ring structure centred on Nathache Hill has a diameter of 500–600 m. Wrench faulting prior to emplacement of the third centre displaced the western half of the Nthache Hill ring structure 250 m to the north. Centre 3 comprises small plugs and thin sheets of metanephelinite and beforsite. The main apatite deposit forms an arcuate zone (300 m N–S and 50m E–W) around the eastern side of the hill.

Drill indicated reserves of 2 Mt of rock phosphate with 17% P_2O_5 have been outlined to a depth of 100 metres (Mining Annual Review, 1999). Within this block 900,000 tonnes are available averaging 22% P_2O_5 and higher grade rock (28-30% P_2O_5) could be selectively mined. There is potential for increasing the ore reserves by investigating the adjacent areas capped by agglomerate. Met-Chem Canada Inc. evaluated the economic potential of the Tundulu phosphate resources for the Malawi Development Corporation and concluded that recovery of niobium and rare earth resources from the carbonatite could contribute to lowering the P_2O_5 cut-off grade and increase the phosphate reserve. The quantity of phosphate rock and the demand for phosphate fertilisers is, nevertheless, probably too small to justify the establishment of a fertiliser manufacturing plant. Agronomic trials have been carried out on the use of ground Tundulu phosphate rock as a direct application fertiliser for tea. It is deemed not reactive enough for annual crops.

JICA (1989–91) delineated three orebodies on Nthache Hill with a total probable reserve of 1,892,480 t at an average grade of 14.4% P_2O_5 using a cut-off of 5% P_2O_5 (i.e. 2.2%P). With a weighted grade of 16.6% P_2O_5 the probable reserves stand at 1,777, 688 t whereas the reserve estimate for the high grade zone of 22.8% is 805,200 t. The drilling indicated continuity of apatite rock to depths >100 m. It should be noted that commercial grade rock phosphate usually contains >60% $Ca_3P_2O_8$ (or TPL). In terms of TPL the Tundulu values are fairly low (<50%). It is evident that should the Tundulu phosphate deposit be mined processing will include crushing and flotation to produce a saleable product. However, for direct application the high grade zone may not require beneficiation.

Apatite occurs in biotite-metapyroxenite in the centre of the Basement Complex Mlindi ultrapotassic ring structure and it is the only known pyroxenite that has some potential for extraction of phosphates. Most of the exploitable reserves (2.4 Mmt @ 7–14% P_2O_5) occur in the residual soils overlying the metapyroxenite.



Map of the Tundulu carbonatite with apatite.

Nepheline Syenite

Nepheline syenite is primarily used in the manufacture of glass and ceramics. By far the largest use of nepheline syenite is in the manufacture of glass products. It is also used for the manufacture of alumina, extender pigments and inert fillers. Grade A nepheline syenite for the manufacture of clear glass contains >23% Al_2O_3, >14% total alkalis and <0.1% Fe_2O_3 with no refractory minerals. The iron content is critical (e.g. for coloured glass and fibre glass it is <0.35% Fe_2O_3) and cathodoluminescence can be used to determine the Fe^{3+} content in the feldspar which may render the material uneconomic.

The economic potential of a nepheline syenite body at Chikangawa, Mzimba District (Brown, 1984) has been assessed. This nepheline syenite forms an oval shaped laccolithic body of c. 20 Km^2. Ten textural types of nepheline syenite are distinguished including banded and pegmatitic types. The Chikangawa rocks are allied petrologically to nepheline monzonite, comprising essentially alkali feldspar, nepheline and biotite. They are peraluminous, miaskitic ($Na_2O+K_2O/Al_2O_3 \leqslant 1$), generally low in iron and very similar to igneous nepheline syenites exploited elsewhere in the world for glass manufacture. The mafic accessory phases are not intimately intergrown with the felsic minerals and could be liberated. Preliminary magnetic separation trials have reduced total iron levels to 0.1% on average and this could be improved upon by selective quarrying and thorough separation treatment. Zircon is a common accessory and would need to be removed before this nepheline syenite could be considered of glass grade. Being a high bulk, low cost material the economic viability of the deposit will depend on development of cheap processing techniques together with an improved transport infrastructure.

The Junguni, Mongolowe and Chinduzi nepheline syenite intrusions in the Zomba district that lie to the north and south of the Nacala railway line respectively are better situated. It might also be possible to exploit nepheline syenite as a byproduct of, or in tandem with, the sodalite quarrying.

Pegmatite Minerals

Malosa Mountain, near Zomba is a site of artisanal exploitation of outstanding pegmatite mineral specimens that are highly prized by collectors. The most celebrated is aegirine associated with smoky quartz, microcline, zircon and other rare species such as parasite, epididymite, fergusonite and eudyalite.

The Zomba-Malosa pluton emplaced at c. 113 Ma is composed of quartz syenite and peralkaline granite is host to associated NYF (Nb-Y-F enriched) granitic alkaline pegmatites characterised by a unique mineralogy including aegirine, arfvedsonite, Ce-pyrochlore, fluorite, hingganite-(Y), Nb-Ta-Y oxides, niobophyllite-astrophyllite, REE-carbonates, several Na-Be-Zr silicates, xenotime-(Y) and zircon. The pegmatites crop out close to the summit of Mount Malosa (c. 2000masl). They are typically 1.0–1.5m thick, subhorizontal and strongly miarolitic locally with metre-scale cavities or 'pockets'. The rock textures and mineral assemblage indicate crystallisation at shallow depth. Moreover there are large euhedral crystals of rare minerals (e.g. Be silicates) in the cavities that show replacements by REE minerals and Zr-Th silicates. To date about 45 mineral species have been identified including galena. The most accessible pegmatites on the summit have been exhausted and the remaining deposits crop out on the steep northwestern fault scarp of the mountain.

Nepheline syenite pegmatites with large well developed aegirine crystals also occur in the Chinduzi-Chikala mountain range. The Mulanje mountain massif may also be prospective for the NYF subclass of rare metal pegmatites.

At Mwanza, sodic pegmatitic rocks with albite and albite-oligoclase carry bi-pyramidal crystals of brown semi-opaque zircon crystals up to 4 cm. A striking feature of the zircons is the absence or only minor development of prisms. Some isometric crystals show a 'soccer-ball' morphology. Corundum is associated with the zircon. No production is reported.

Corundum occurs in pegmatites hosted by a biotite nepheline gneiss to the west and south of Makoko village in Nsanje; a similar environment to that of Thambani in the Mwanza district. Some of the corundum is blue but no gem-quality sapphires have been reported.

Sövite
Sövite (or soevite), the calcite-rich end member of the carbonatite family can be used in the same way as low magnesia limestones and calcitic marbles but rarely occurs in sufficiently pure form. The relatively high contents of rare earth elements, Sr, Ba, Mn, Fe and possibly phosphate could present a problem for any potential utilisation.

The two main silicate-poor sövite-bearing carbonatites are Tundulu and Chilwa Island. The northeastern slopes of the Tundulu Hill ring complex contains bands of low magnesia sövite (>90% total carbonate, 50.9% CaO and 0.8%MgO) over 300 m long and up to 120 m wide. Although their close association with agglomerates means that the thickness varies considerably along strike several million tonnes of sövite are indicated. Sövite of varying purity forms a major part of the Chilwa Island carbonatite. In places it contains abundant xenoliths of feldspathic breccia and much of the sövite is ankeritic. Nevertheless large quantities of relatively pure sövite (52.1% CaO and 0.18% MgO) are available. Potential exploitation of phosphate (Tundulu) or pyrochlore (Chilwa Island) could make this resource an attractive proposition.

Dimension stone
Azure-blue sodalite syenites are one of the most sought-after dimension stones associated with the alkaline intrusive complexes in Malawi.

Sodalite-nepheline syenite of the Ilomba intrusion at Chitipa in north Malawi is quarried for dimension stone by Ilomba Granite of Blantyre and is known under the trademark of 'blue granite'. It occurs in small areas within biotite-nepheline syenite with gradational boundaries. The coarse grained rock predominantly comprises alkali feldspar and sodalite. Biotite, apatite, plagioclase and calcite are present only in minor amounts.

The Ulindi hill nepheline syenite intrusion, which lies 6.5 km east of Ilomba within the Songwe Syenite, also contains irregular and discontinuous sodalite veins in the summit area.

'Blue granite' also occurs in the Rumphi district.

Sodalite syenite also occurs at Junguni Hill of the Cretaceous Chilwa Alkaline Province in the Balaka district of central Malawi. This is situated close to the Nacala railway and the major population centres. Sodalite is locally abundant (up to 90%) and occasionally occurs as rounded masses, interstitial patches and in rectangular areas within feldspar prisms.

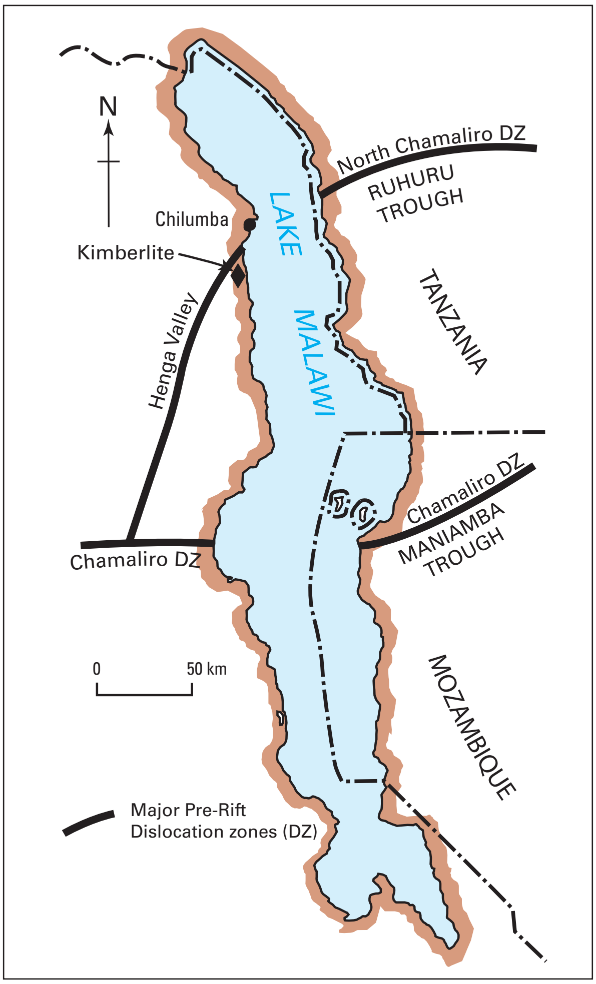
Amazonite granite, colloquially known as 'Green Granite', occurs in the Ezondweni-Mtwalo area of the Mzimba district of central Malawi and is worked by Granite Ltd. Amazonite is an opaque to translucent bluish-green variety of microcline feldspar that occurs in alkali granites and pegmatites. The green colour is largely due to an elevated lead content. Large amazonite crystals are reported from pegmatites on Mount Malosa, near Zomba.

Polished slab of amazonite-rich 'green granite'.

Kimberlites and diamond potential
Kimberlites are a type of potassic volcanic rock best known for sometimes containing diamonds and they remain the main source of diamonds. Their morphology is the result of explosive diatreme volcanism from mantle sources at depths of 150–450 km. Diamonds typically occur in the deep roots of Archaean/Paleoproterozoic cratons from where they are incorporated by the rising kimberlitic magmas. Diamondiferous kimberlites comprise tabular vertical-dipping feeder dykes that evolve into a volcano with a central vent (commonly referred to as a pipe) within 1.5–2.0 km of surface as the highly pressurised magma explodes upwards and expands to erupt at the Earth's surface. The diameter of the pipe at surface is typically a few hundred metres to a kilometre but exceptionally can be several kilometres across. Only 1 in 200 kimberlite pipes have economic diamond potential.

The western branch of the East African Rift is characterised by Group II kimberlites which are ultrapotassic peralkaline rocks rich in volatiles that have close affinity to lamproites. The alkaline magmas are derived from deep sources in the mantle plume beneath the continental rift and commonly lead to the genesis of nephelinite-carbonatite and kimberlite-carbonatites. Kimberlitic rocks in the Chapachenga area near Phirilongwe Mountain in Mangochi have a carbonatite affinity. They are currently being investigated by the Geological Survey Department.

It has often been claimed that the geological situation in Malawi-Mozambique is not particularly favourable for the occurrence of diamondiferous kimberlites on the grounds that kimberlites in the vicinity of the East African Rift are barren. However about 50% of these so-called barren kimberlites are reported to carry some diamonds. Although much of Malawi and neighbouring parts of western Mozambique comprises reworked crystalline crust, recent work has shown that older cratonic fragments occur in this geological environment. The kimberlites in north-western Mozambique occur at the north-east extremity of the NE–SW-trending transcontinental kimberlite corridor that extends from South Namibia. The Maniamba basin (or graben), which extends NE of Lake Malawi and is infilled with Karoo Supergroup sediments, contains numerous dykes (up to 3m thick) and small pipes (several tens of metres) of primitive Group 1 kimberlite of Lower Cretaceous age (c.140 Ma). The Mozambiquan diatremes are located at the intersection of the NE- and NNW-trending fault systems within the graben. No kimberlite bodies are found beyond the margin of the Karoo cover. NW-trending kimberlitic zones of Mefululutxe and Fùgoè are up to 28 km long and located only 4–7 km from Lake Malawi. It has yet to be established whether they carry diamonds but it is quite common for barren Group



Karoo graben on the trans-continental kimberlite corridor.

1 kimberlite dykes to be associated with diamondiferous pipes.

The known kimberlites of NW Mozambique show up as positive anomalies on recently flown high-resolution airborne magnetic data which has also revealed a number of previously unknown kimberlite dykes that are now being investigated.

Kimberlitic dykes are known to occur in the Karoo rocks of the Livingstonia subbasin and the UNDP aerogeophysical survey in the 1980s also indicated targets for diamondiferous kimberlites in the west Chiumba diatreme zone in the Karonga district of northern Malawi. The Chamaliro dislocation zone that borders the Maniamba trough and its northern branch that borders the Ruhuru trough and southern margin of the Livingstonia sub-basin are therefore considered prospective zones for kimberlites. Kimberlitic dykes are also reported in the Mwanza River Valley in the districts of Chikwawa and Mwanza. Previous diamond prospection reportedly revealed kimberlite indicator minerals and two microdiamonds in a concentrate taken from the Shire River.

Base metal potential

Amongst the ring complexes only Mlindi and Chingale have been adequately sampled. Random Cu-Ni anomalies (max 340 ppm Cu and 680 pp Ni) and copper minerals have been noted at Mlindi. Isolated soil sample anomalies (max 2560 ppm Cu and 1600 ppm Ni) have been recorded over the biotitites. The Kangankunde carbonatite contains significant accessory amounts of sphalerite, baryte and manganese oxides along with monazite and strontianite. Sphalerite (0.4-0.5%) and baryte (0.6-0.7%) equivalent to 1654 t and 9250 t respectively per 30 m depth could be extracted as byproducts of the mining of monazite. There are a number of coincident tin-molybdenum-niobium geochemical anomalies associated with the alkaline intrusions of Phirilongwe (Mangoche), Nkalabe (Nyika), Mbale (Nsanje) and Chekang'ombe (Nkamanga). Potential exists for tin mineralisation in association with final phase A-type peralkaline granites and episyenites of the Chilwa Alkaline Province.

Brochures in the series on the Mineral Potential of Malawi

1. Mineral deposits associated with alkaline magmatism.
2. Mineral deposits associated with the Basement metamorphic and igneous rocks.
3. Mineral deposits associated with sedimentary and volcanic cover rocks: Karoo and post-Karoo.
4. Deposits resulting from residual weathering, placer and rift-related sedimentation.

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