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Petrology of the sedimentary and igneous rocks exposed in the Ayr District (Sheet 14W), Scotland

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Petrology of the sedimentary and igneous rocks exposed in the Ayr District (Sheet 14W), Scotland

E. R. Phillips

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Keyworth, Nottingham NG12 5GG

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Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

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Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

Foreword

This report is the published product of a study by the British Geological Survey (BGS) as part of their regional geological mapping programme. It describes the mineralogy and petrology of a suite of sedimentary and igneous rocks exposed in the Ayr District (Sheet 14W), Scotland. The work forms part of a multidisciplinary Midland Valley Project.

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Summary

This report describes the mineralogy and petrology of a suite of sedimentary and igneous rocks exposed in the Ayr District (Sheet 14W), Scotland. The work forms part of a multidisciplinary project being undertaken by the British Geological Survey to examine the evolution of the Midland Valley terrane of Scotland.

1 Introduction

This report describes the mineralogy and petrology of a suite of sedimentary and igneous rocks exposed in the Ayr District (Sheet 14W), Scotland. A total of 51 thin sections have been examined with the work forming part of a multidisciplinary project being undertaken by the British Geological Survey to examine the evolution of the Midland Valley terrane of Scotland. The samples were collected by Ms Sarah Arkley during the re-mapping of the Ayr District (1:50,000 Geological Map Sheet 14W).

2 Thin section descriptions

2.1 BENAN CONGLOMERATE FORMATION

Collectors Number: SRK 104 **Registered Number:** N2974 **Location:** [NS 3303 0081] Fore Craig, 700 m northeast of The Pilot **Rock Type:** microconglomerate rich in limestone lithic clasts **Formation:** Benan Conglomerate Formation (Ordovician)

Description: This thin section is of a coarse-grained, poorly sorted, immature, heterolithic microconglomerate which possesses an open to very open packed, cement supported texture. The clasts range in size from fine-sand up to small pebbles, but are dominated by medium to very coarse sand sized material. The clasts are subrounded to well rounded in shape with a low to occasionally moderate sphericity. The well-rounded shape of the clasts suggests that they may polycyclic in nature and may also include broken fragments of larger pebbles.

The clast assemblage is dominated by limestone and basic igneous rock fragments. Localised pressure solution was noted between adjacent limestone lithic clasts. The detrital assemblage includes altered basalt, peloids, crinoid fragments, bivalve fragments, very fine-grained massive limestone, hematised basaltic rock, ooids, altered metagabbro, variolitic basalt, serpentinite, pisoids and aggregate limestone grains. Other minor to accessory detrital components include rhyolite, felsite, chert, siltstone/very fine-grained sandstone, granitic rock, monocrystalline quartz, opaque minerals, polycrystalline quartz, plagioclase and chloritised biotite. The larger clasts tend to be composed of igneous material with the sand-grade lithic clasts being of fine-grained limestone.

An early isopachous rim cement is locally developed upon detrital grains. The development of the main sparry carbonate cement resulted in the etching of clast boundaries. Localised pressure solution was noted along grain contacts.

Collectors Number: SRK 105 **Registered Number:** N2975 **Location:** [NS 3296 0084] Fore Craig, 675 m northeast of The Pilot **Rock Type:** altered (chloritised), fine-grained, lithic-rich sandstone (litharenite) **Formation:** Benan Conglomerate Formation (Ordovician)

Description: This thin section is of a fine-grained, immature, laminated, altered (chloritised), clast supported, closely to moderately packed, lithic-rich sandstone (litharenite) which possesses a well developed chloritic cement or matrix. The overall appearance of the sandstone suggests that it may have undergone very low-grade metamorphism. The patchy development of a secondary, replacive carbonate cement results in the localised overprinting of the original clastic texture of the rock. The sedimentary lamination is defined by a variation in the grain size and preferential carbonate replacement of certain laminae.

Angular to subangular, moderate sphericity detrital grains are mainly composed of variably degraded lithic clasts, plagioclase and quartz. The shape of the clasts has locally been modified due to the close packed nature of the sandstone and effects of subsequent alteration. The protolith of the lithic clasts is uncertain due to the intensity of this alteration. However, it is possible that the . Other minor to accessory detrital components include opaque minerals, variably chloritised biotite, chlorite, serpentinite, chloritised rock and basalt rock fragments.

Collectors Number: SRK 119 **Registered Number:** N2980 **Location:** [NS 3399 0107] quarry, 450 m northeast of Knockincullock **Rock Type:** coarse-grained, lithic-rich sandstone (litharenite) or microbreccia with a replacive carbonate cement **Formation:** Benan Conglomerate Formation (Ordovician)

Description: This thin section is of a coarse-grained, poorly sorted, immature, lithic-rich, highly altered, cement supported sandstone (litharenite) or microbreccia which possesses a well-developed carbonate cement. The carbonate is probably replacing the original matrix to the sandstone as well as unstable lithic clasts. Preserved detrital grains are angular to occasionally subangular in shape with a low sphericity. However, the shape of these clasts has locally been modified during the development of the carbonate cement. This included the etching of quartz grain boundaries. The carbonate cement is fine-grained with a dusty appearance in plane polarised light.

The clast assemblage is dominated by monocrystalline quartz with subordinate carbonate replaced lithic fragments. Monocrystalline quartz is strained and possesses a variably developed undulose extinction. Polycrystalline quartz clasts are also present and include sheared vein quartz and/or mylonitic rock fragments. These deformed quartzose clasts are distinctive feature of this sandstone. Other minor to accessory detrital components include opaque minerals, carbonate rock/limestone, felsite, deformed ?granitic rock, chloritised rock or serpentinite, feldspar and sericitised feldspar.

The rock is cut by a number of thin carbonate (± quartz) veinlets.

2.2 BLAIR SHALES FORMATION

Collectors Number: SRK 120 **Registered Number:** N2981 **Location:** [NS 3294 0242] Glenmartin Burn, 525 m east of Blair Farm **Rock Type:** immature, quartzose, lithic-rich

sandstone (quartzose litharenite or wacke sandstone) **Formation:** Blair Shales Formation (Silurian)

Description: This thin section is of a fine-grained, poorly sorted, immature, closely packed, clast supported, quartzose, lithic-rich sandstone (litharenite) in which the unstable detrital and matrix components are patchily replaced by small, single crystals of carbonate or a fine-grained carbonate aggregate. Detrital grains are angular to subangular in shape with a moderate to low sphericity. The mixed clast assemblage is composed of monocrystalline quartz and lithic fragments. The protolith to these lithic fragments is uncertain due to the fine-grain size of the sandstone and subsequent alteration. However, lithologies may have included felsite, metasandstone, very fine-grained metasedimentary rock and mudstone. Other minor to accessory detrital components include plagioclase, variably chloritised biotite, muscovite, opaque minerals, chlorite, garnet, polycrystalline quartz, zircon and spinel. Detrital micas are a common minor component within this sandstone.

Compaction resulted in localised pressure solution between quartzose grains and kinking of detrital micas. A weak preferred shape alignment of elongate clasts is also developed.

2.3 KNOCKGARDNER FORMATION

Collectors Number: SRK 142 **Registered Number:** N2988 **Location:** [NS 3305 0269] Lady Burn, 125 m south-southwest of Culloch Knowes **Rock Type:** heterolithic, very coarse-grained sandstone (litharenite) or microconglomerate **Formation:** Knockgardner Formation (Silurian)

Description: This thin section is of a poorly sorted, very coarse-grained, immature, heterolithic, lithic-rich, clast supported sandstone (litharenite) or microconglomerate containing minor amounts of a very fine-grained sandstone to siltstone matrix. The siltstone matrix possesses a finely cryptocrystalline, green coloured chloritic or clay cement.

Detrital grains are typically angular to subrounded in shape with a low to moderate sphericity. However, occasional rounded grains are also present. The clast assemblage is dominated by lithic fragments with subordinate monocrystalline and polycrystalline quartz. A major proportion of the lithic clasts appear to be composed of a very fine-grained sedimentary and/or volcanic rock. Recognisable lithologies include chloritised basalt, chalcedonic quartz, chloritic siltstone, silicified rhyolite, aphyric dacite, feldspar-phyric dacite, sheared vein quartz or mylonite, quartz-phyric rhyolite, metagabbro, ultramylonite or schistose rock, chert, hematised rock, metabasalt, microdiorite, mudstone, carbonate rock or recrystallised limestone, carbonate replaced siltstone, fine-grained sandstone and micrographic intergrowth (granite). Other minor to accessory detrital components include plagioclase, chlorite, opaque minerals, chloritised biotite and garnet.

Minor amounts of a replacive carbonate cement was noted forming rims upon the larger detrital grains. The carbonate appears to be replacing the chloritic siltstone matrix to this microconglomeratic rock. Compaction resulted in localised pressure solution between quartzose grains and plastic deformation and embayment of unstable lithic clasts against neighbouring more rigid grains. Localised (? rare) fracturing of these rigid grains, probably in response to compaction, was also noted.

2.4 DRUMYORK FLAGS FORMATION

Collectors Number: SRK 95 **Registered Number:** N2970 **Location:** [NS 3412 0287] Balsaggart Glen, 500 m southeast of Shaw's Knowe **Rock Type:** laminated fine-grained, siltstone **Formation:** Drumyork Flags Formation (Silurian)

Description: This thin section is of a fine-grained, laminated siltstone which contains thin wispy looking opaque oxides occurring parallel to the sedimentary lamination. The lamination is defined by slight changes in grain size of the silt-grade clasts and colour of the clay matrix. Small detrital grains are mainly composed of monocrystalline quartz, white mica and opaque oxides. The grains are angular in shape. Other minor to accessory detrital components present include chlorite, biotite and plagioclase. Traces of replacive carbonate and a thin carbonate mineral vein are also present.

Collectors Number: SRK 127 **Registered Number:** N2983 **Location:** [NS 3110 0139] hill side, 75 m west of Barony Hill **Rock Type:** fine-grained, quartzose sandstone **Formation:** Drumyork Flags Formation (Silurian)

Description: This thin section is of a fine-grained, immature, moderately to well sorted, laminated, closely to very closely packed, clast supported, quartzose sandstone which contains minor amounts of a primary porosity. The sedimentary lamination is highlighted by a slight variation in grains size and sandstone composition. Detrital grains are subangular to subrounded in shape with a low to moderate sphericity. The clast assemblage is dominated by monocrystalline quartz with subordinate variably degraded rock fragments and feldspar. The degradation of the unstable detrital components has resulted in the development of a secondary matrix component within the sandstone. The protolith of the lithic clasts is uncertain due to the fine grain size of the rock coupled with the intensity of alteration of the unstable detrital components. However, the least altered lithic clasts appear to be composed of volcanic rock fragments, very fine-grained metasedimentary rock and siltstone. Minor to accessory detrital components include polycrystalline quartz, plagioclase, muscovite, chlorite, variably chloritised biotite, microcline, opaque minerals, tourmaline, garnet, zircon and chloritised rock or serpentinite.

The sandstone possesses a well-developed yellow green coloured clay or chloritic rim cement. Compaction resulted in the kinking of detrital micas and localised pressure solution between adjacent quartzose grains.

2.5 SWANSHAW FORMATION

Collectors Number: SRK 108 **Registered Number:** N2976 **Location:** [NS 3247 0112] Shiel Burn, 600 m south-southeast of Cairn Hill **Rock Type:** very coarse-grained, quartzose lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a closely to very closely packed, matrix-poor, clast supported, immature, poorly to very poorly sorted, quartzose, lithic-rich sandstone (quartzose litharenite). Detrital grains are typically angular to subangular in shape with a low to moderate sphericity. The mixed clast assemblage is mainly composed of lithic clasts, monocrystalline quartz and plagioclase. The lithic clasts are mainly composed of hematised siltstone to very fine-grained sandstone, as well as very fine-grained volcanic rock. The shape of these unstable lithic clasts has been modified during compaction, becoming embayed against neighbouring more rigid, typically quartzose, grains. Other minor to accessory detrital components include polycrystalline quartz, cherty rock, muscovite, hematised mudstone, zircon, very fine-grained schist/phyllite, biotite, metasedimentary rock and dacitic rock.

Traces of a very fine clay or chloritic cement have been recognised which post-dated the development of an early hematitic rim cement which locally coats some detrital grains. Compaction resulted in the kinking of detrital micas and localised pressure solution between adjacent quartz grains.

Collectors Number: SRK 110 **Registered Number:** N2977 **Location:** [NS 3270 0125] Shiel Burn, 575 m southeast of Cairn Hill **Rock Type:** calcareous sandstone with occasional mudstone rip-up clasts Formation: Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to possibly medium-grained, poorly sorted, moderately to closely packed, clast supported, altered, originally lithic-rich, quartzose sandstone (litharenite) which contains occasional pebble sized mudstone rip-up clasts. Detrital grains are angular to subrounded in shape with a low to moderate sphericity. The mixed clast assemblage is composed of monocrystalline and polycrystalline quartz as well as variably altered rock fragments. The lithic clasts and any original matrix component (if any) to the sandstone have been preferentially replaced by carbonate. Recognisable minor to accessory detrital components present include fragments of a very fine-grained metasedimentary rock, muscovite, carbonate rock/limestone, mudstone, opaque minerals, tourmaline and plagioclase.

Collectors Number: SRK 114 **Registered Number:** N2978 **Location:** [NS 3327 0149] Shiel Burn, 950 m east-southeast of Cairn Hill **Rock Type:** altered, quartzose, lithic-rich sandstone (litharenite) comparable to N2977 **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to medium-grained, moderately sorted, immature, closely to very closely packed, clast supported, massive, quartzose, lithic-rich sandstone (litharenite). This thin section is comparable to sample N2977. The lithic clasts and matrix component (if any) of this sandstone have been replaced by secondary carbonate. The lithic clasts were apparently highly altered to a colourless to very pale green chloritic assemblage prior to carbonate replacement. Consequently, the protolith for these lithic clasts is uncertain.

Detrital grains are angular to subangular in shape with a low to moderate sphericity. However, the shape of the unstable detrital components (e.g. rock fragments) has been modified during the carbonate alteration and as a result of the very close packing of the sandstone. Carbonate development also locally results in the etching of quartz grain boundaries. The clast assemblage

is dominated by degraded or altered lithic clasts and monocrystalline quartz. Other minor to accessory detrital components include polycrystalline quartz, white mica, opaque minerals, zircon, very fine-grained sandstone or siltstone and amphibole. Compaction resulted in the kinking of detrital micas and localised pressure solution between adjacent quartzose clasts.

Collectors Number: SRK 116 **Registered Number:** N2979 **Location:** [NS 3327 0149] Shiel Burn, 750 m south-southeast of Brownford Bridge **Rock Type:** altered, quartzose, lithic-rich sandstone (litharenite) comparable to N2978 **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine-grained, poorly sorted, immature, closely to very closely packed, massive, quartzose, possibly originally lithic-rich sandstone (litharenite). This sample is comparable to N2978. Unstable lithic clasts and feldspar are altered to a cryptocrystalline chloritic, clay or sericitic assemblage. Although altered the original grain shape of these unstable grains can still locally be recognised under plane polarised light. Preserved, more stable, clastic grains are angular to subangular in shape with a low to moderate sphericity. The shape of these typically quartzose grains have, however, been modified due to grain boundary etching. Rare subrounded grains have also been recorded. The clast assemblage was apparently dominated by lithic clasts and monocrystalline quartz. Other minor to accessory detrital components include chloritised biotite, polycrystalline quartz, chloritised ferromagnesian mineral(s), opaque minerals, muscovite/white mica, zircon and tourmaline. It is possible that the lithic clasts may have been largely composed of a very fine-grained volcanic/tuffaceous rock or argillaceous sedimentary rock fragments.

The altered lithic clasts, matrix and possibly feldspar have been patchily replaced by fine-grained dusty brown coloured to clear carbonate. Compaction resulted in the localised pressure solution between adjacent quartzose grains. Small irregular patches of a very fine-grained to cryptocrystalline chloritic cement have also been noted within this sandstone.

Collectors Number: SRK 128 **Registered Number:** N2984 **Location:** [NS 3103 0134] hill top, 150 m southwest of Barony Hill **Rock Type:** quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium- to coarse-grained, poorly very poorly sorted, immature, moderately to closely packed, clast supported, quartzose, lithic-rich sandstone (quartzose litharenite). Detrital grains are subangular to rounded in shape with a low to moderate sphericity. The coarse sand-grade clasts tend to be more rounded in shape and may be polycyclic in origin. These rounded clasts represent a distinctive feature of this sandstone. The clast assemblage is dominated by monocrystalline quartz with subordinate lithic clasts and polycrystalline quartz. Recognisable lithologies forming the lithic clasts include quartzite, cryptocrystalline cherty rock or felsite, sericitised mudstone, pilotaxitic volcanic rock, psammite, mudstone or tuffaceous rock, hematised basaltic rock and siltstone. Minor to accessory detrital components include plagioclase, chlorite pseudomorphs after detrital ferromagnesian minerals, opaque minerals, muscovite, biotite, tourmaline, zircon and garnet.

A chloritic or sericitic rim cement is developed forming a coating to some detrital grains. Compaction resulted in localised pressure solution between adjacent quartzose grains as well as plastic deformation and embayment of unstable lithic fragments against neighbouring more rigid

quartzose grains. The fine grained matrix component of the sandstone appears to have been partially derived from the breakdown of unstable lithic clasts. Minor amounts of possibly primary, intergranular porosity was noted.

Collectors Number: SRK 135 **Registered Number:** N2986 **Location:** [NS 3061 0073] burn, 500 m east-northeast of Dobbingstone **Rock Type:** coarse-grained, quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a coarse-grained, poorly to very poorly sorted, immature, closely to very closely packed, clast supported, heterolithic, quartzose, massive, lithic-rich sandstone (quartzose litharenite). The detrital grains are typically angular to subangular in shape with a low to moderate sphericity. However, occasional subrounded clasts are also present. The shape of the more unstable detrital grains has been modified during compaction due to embayment against neighbouring more rigid quartzose grains. There is very little or no obvious porosity or matrix within this sandstone. The very close packing of the sandstone locally makes it difficult to identify individual clast boundaries. Minor amounts of carbonate are present replacing unstable lithic clasts and locally partially encloses quartzose grains.

The mixed clast assemblage is dominated by monocrystalline quartz, chloritised lithic clasts and subordinate plagioclase. Recognisable lithic fragments are composed of mudstone or tuffaceous rock, foliated low-grade meta-siltstone, plagioclase-phyric basalt or andesite, psammite, chloritic mudstone and siltstone, metabasaltic rock, siltstone to very fine-grained sandstone, very fine-grained hornfels, chert, hematised volcanic rock, felsite, mudstone and carbonate replaced mudstone. Other minor to accessory detrital components include muscovite, polycrystalline quartz, chloritised biotite, opaque minerals, garnet, chloritised rock or ferromagnesian minerals and tourmaline.

The very minor to accessory amounts of matrix present within the sandstone is possibly derived from the breakdown of the lithic clasts. The secondary carbonate appears to be preferentially replacing the lithic clasts and matrix. Occasional granule sized clasts have been recorded.

Collectors Number: SRK 161 **Registered Number:** N2996 **Location:** [NS 3398 1374] bank side of River Doon, 625 m north-northwest of woodland **Rock Type:** calcareous, fine- to medium-grained, quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to medium-grained, moderately sorted, immature, laminated, calcareous, moderate to open packed, cement supported to locally clast supported, quartzose, lithic-rich sandstone (quartzose litharenite). A distinctive feature of this sandstone is the presence of shape aligned, locally kinked and variably oxidised detrital biotite flakes. These biotite flakes are aligned parallel to the sedimentary lamination (i.e. bedding). The lamination is defined by a slight change in sandstone composition (i.e. quartz versus lithic component within the sandstone).

Detrital grains are angular to subrounded in shape with a low to occasionally moderate sphericity. The shape of the clasts has, however, locally been modified during the development

of the carbonate cement. This cement appears to be replacing the original matrix to the sandstone as well as unstable lithic and feldspar clasts. The cement is composed of fine- to very fine-grained carbonate which contains relict partially replaced unstable detrital grains.

The clast assemblage is dominated by variably altered lithic fragments and monocrystalline quartz. The lithic clasts appear to have been mainly composed of very fine-grained sedimentary, tuffaceous and/or volcanic rock fragments. Other minor to accessory detrital components include muscovite, phyllitic or slaty metamorphic rock fragments, hematised rock, hematised biotite, chlorite pseudomorphs after ferromagnesian mineral, very fine-grained psammite, chlorite, garnet, opaque minerals, zircon, polycrystalline quartz and plagioclase.

Collectors Number: SRK 162 **Registered Number:** N2997 **Location:** [NS 3137 1476] Pinmore Burn, 475 m northwest of Culroy Bridge **Rock Type:** fine-grained sandstone with hematised matrix **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to very fine-grained, relatively quartz-rich, moderately sorted, open packed, clast to matrix supported, immature sandstone which possesses a distinctive hematised matrix. A well-developed hematitic or clay rim cement is also present within this sandstone.

Detrital grains are subangular to subrounded in shape with a low to moderate sphericity. The clast assemblage is dominated by monocrystalline quartz with subordinate lithic fragments. It is possible that the matrix component of this sandstone is derived from the degradation of unstable lithic clasts. The protolith of these lithic fragments is uncertain due to the fine-grained nature of the rock and intensity of hematitic alteration. Other minor to accessory detrital components include muscovite, opaque minerals, polycrystalline quartz, very fine-grained volcanic rock, chloritised biotite, very fine-grained sandstone and zircon.

Collectors Number: SRK 163 **Registered Number:** N2998 **Location:** [NS 3145 1471] Pinmore Burn, 375 m northwest of Culroy Bridge **Rock Type:** medium-grained, quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, closely to very closely packed, clast supported, immature, low porosity, poorly sorted, quartzose, lithic-rich sandstone (quartzose litharenite). Detrital grains are angular to subangular in shape with a low to occasionally moderate sphericity. The shape of the unstable lithic clasts have locally been modified due to embayment against neighbouring more rigid grains during compaction.

The mixed detrital assemblage is mainly composed of monocrystalline quartz, lithic fragments and subordinate to minor feldspar. The lithic clasts are composed of a wide range of very fine-grained volcanic, metamorphic and sedimentary lithologies including felsite, cherty rock, very fine-grained phyllite or schist, mudstone, siltstone, hematised basaltic rock and altered very fine-grained sandstone. Other minor to accessory detrital components include plagioclase, muscovite, polycrystalline quartz, opaque minerals, variably oxidised biotite, polycrystalline plagioclase, garnet, perthite and microcline.

This sandstone contains very little obvious porosity and trace amounts of secondary carbonate replacing the original matrix. The matrix is composed of a yellow-brown chlorite or clay filling pore spaces and a darker coloured clay forming rims or coatings upon detrital grains. A weak shape alignment of elongate detrital grains and micas was recorded. Compaction resulted in the kinking of the detrital micas.

Collectors Number: SRK 164 **Registered Number:** N2999 **Location:** [NS 3149 1468] Pinmore Burn, 325 m northwest of Culroy Bridge **Rock Type:** medium-grained, quartzose, lithic-rich sandstone (quartzose litharenite) comparable to N2998 **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, moderately to closely packed, clast supported, immature, massive, poorly sorted, low porosity, quartzose, lithic-rich sandstone (quartzose litharenite). This sandstone is lithologically similar to sample N2998.

Detrital grains are typically angular to subangular in shape with a low to moderate sphericity. However, occasional subrounded detrital grains are also present. The mixed clast assemblage is dominated by monocrystalline quartz and variably altered rock fragments. The lithic clasts appear to have been mainly composed of very fine-grained volcanic or tuffaceous rock. Other recognisable lithologies include felsite, cherty rock, sericitised rock, very fine-grained phyllite or schist, very fine-grained basalt or basaltic andesite, very fine-grained metasandstone and mudstone. Minor to accessory detrital components include plagioclase, sericitised feldspar, muscovite, variably oxidised biotite, microcline, polycrystalline quartz, chloritised rock, opaque minerals and biotite.

Traces of a secondary, replacive carbonate cement have been noted replacing the matrix to this sandstone. Carbonate also forms isopachous rims upon detrital grains. Compaction resulted in the kinking of detrital micas and plastic deformation of unstable lithic clasts which become embayed against neighbouring more rigid grains. A yellow to yellow-brown clay matrix or cement was locally observed forming rims or coatings upon clasts.

Collectors Number: SRK 166 **Registered Number:** N3000 **Location:** [NS 3159 1462] Pinmore Burn, 325 m northwest of Culroy Bridge **Rock Type:** medium- to coarse-grained, quartzose, lithic-rich sandstone (quartzose litharenite) comparable to N2999 **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium- to coarse-grained, moderately to closely packed, clast supported, poorly sorted, immature, low porosity, quartzose, lithic-rich sandstone (quartzose litharenite). This sandstone is lithologically similar to samples N2998 and N2999.

Detrital grains are angular to subrounded in shape with a low to moderate sphericity. The shape of the unstable detrital components has been modified during compaction which resulted in the embayment of these clasts against neighbouring more rigid quartzose grains. Minor to rare fracturing of these more rigid grains was also noted. The mixed clast assemblage is dominated by monocrystalline quartz and variably altered rock fragments. In this heterolithic sandstone the lithic clasts appear to be mainly composed of very fine-grained volcanic or tuffaceous rock. Recognisable lithologies include felsite, pelitic schist, granitic rock, altered siltstone or very fine-

grained sandstone, psammite, hematised basaltic rock and siltstone. Metamorphic lithics appear to be a common minor component within this sandstone. Other minor to accessory components include opaque minerals, 5muscovite, variably altered biotite, polycrystalline quartz, perthite, plagioclase and sericitised feldspar.

A yellow-brown to brown coloured clay matrix is locally replaced by secondary carbonate. The carbonate locally forms isopachous rims upon detrital grains and may be possibly mimetically replacing an earlier developed clay coating. A weak alignment of detrital micas and elongate detrital grains has been recorded within this sandstone. Very little obvious evidence of a primary porosity has been recognised within this sample.

Collectors Number: SRK 168a **Registered Number:** N3001 Location: [NS 3157 1455] Pinmore Burn, 75 m northwest of Culroy Bridge **Rock Type:** coarse-grained, calcareous, pebbly sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a poorly to very poorly sorted, coarse-grained, pebbly, lithic-rich, calcareous, pebbly sandstone (litharenite) with a very open packed, cement supported texture. This sandstone also possesses a low porosity. The rock contains large, 5.0 to 7.0 mm long, clasts of a fine-grained carbonate rock representing either limestone rock fragments or calcareous concretion (cornstone). Internally these lithic clasts are massive. However, a number of these clasts do contain relict biotite and quartz detrital grains, suggesting that the clasts represent fragments of a highly altered sandstone. The original matrix and/or earlier developed cements, as well as unstable detrital components, have been replaced by fine-grained sparry carbonate. Although highly altered, the ghost outlines of the replaced detrital grains can still be recognised under plane polarised light. In crossed polarised light, however, these relict clastic textures are completely obscured.

Relict detrital grains range from subangular to rounded in shape with a low to moderate sphericity. The shape of the clasts has locally been modified during the development of the carbonate cement. The relict clast assemblage is dominated by monocrystalline quartz and lithic fragments. Recognisable lithologies forming the lithics clasts include felsite, very fine-grained basaltic rock, very fine-grained phyllite and siltstone. The majority of the lithic clasts, however, appear to have been composed of a very fine-grained basaltic to andesitic rock. Other minor to accessory detrital components include muscovite, biotite, opaque minerals, sericitised feldspar or rock, perthite, polycrystalline quartz, micrographic intergrowth and plagioclase.

The carbonate cement is crystalline and appears to be of a single generation. Rarely preserved zonation has locally been recognised within the carbonate crystals. This zonation is defined/preserved by very thin films/foils of clay minerals. A weakly developed alignment of elongate detrital grains is present within this sandstone.

Collectors Number: SRK 170 **Registered Number:** N3002 **Location:** [NS 3418 1256] drainage ditch, 275 m south-southeast of Cassillis House **Rock Type:** very fine-grained sandstone or coarse siltstone **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a very fine-grained, poorly sorted, immature, grain supported, laminated and/or cross laminated sandstone or coarse siltstone. The lamination is defined by a slight variation in the modal proportion of detrital mica. Angular to subangular detrital grains possess a low sphericity and are mainly composed of variably degraded rock fragments and monocrystalline quartz. The protolith of the lithic clasts is uncertain due to the very fine-grain size of the rock. Detrital muscovite and oxidised biotite are common components within this very fine-grained sandstone. The detrital micas are variably aligned parallel to the sedimentary lamination. Other minor to accessory detrital components include plagioclase, chlorite, opaque minerals, polycrystalline quartz, zircon and apatite.

Minor to trace amounts of secondary carbonate is present replacing the clay component and/or unstable lithic clasts within this very fine-grained sandstone/siltstone. Compaction resulted in the kinking of detrital micas. Traces of a chlorite pore filling cement is developed within this sandstone.

Collectors Number: SRK 174 **Registered Number:** N3003 **Location:** [NS 3410 1290] bank side of River Doon, 100 m northeast of Cassillis House **Rock Type:** laminated, very fine-grained sandstone or coarse siltstone **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a very fine-grained, poorly sorted, immature sandstone or coarse siltstone. The primary sedimentary lamination is defined by a slight variation in the grain size and modal proportion of detrital opaque minerals. Individual laminae may be weakly graded (normal grading). Detrital grains are angular to subangular in shape with a low to moderate sphericity. The elongate grains are variably shape aligned parallel to the sedimentary lamination. Detrital components include monocrystalline quartz, opaque minerals, volcanic rock fragments, variably chloritised biotite, muscovite and plagioclase. Trace amounts of a pale green chloritic cement have also been noted.

Minor to trace amounts of secondary carbonate are present replacing the clay component within this sandstone. The carbonate was also noted forming distinctive rounded to lenticular shaped spots or clasts. This sandstone or coarse siltstone appears to have originally been feldspathic in nature, with feldspar having broken down to form, at least in part, the matrix to this sedimentary rock.

Collectors Number: SRK 187 **Registered Number:** N3007 **Location:** [NS 3069 1210] Brockloch Burn, 325 m north-northwest of St. Murrays **Rock Type:** altered, fine- to medium-grained sandstone **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to medium-grained, closely to very closely packed, clast supported, low porosity, immature, altered, moderately to possibly poorly sorted sandstone. The majority of the unstable detrital components (e.g. feldspar and/or rock fragments) within this sandstone have been replaced by a very finely cryptocrystalline assemblage of chlorite, sericite and quartz. Detrital grains are angular to subangular in shape with a low to occasionally moderate sphericity. Rare subrounded clasts are also present. The shape of the detrital grains have been modified during compaction, leading to the embayment of unstable grains against neighbouring more rigid clasts. The very close packing and alteration of the sandstone locally makes it difficult to identify individual clast grain boundaries. The sandstone originally appears

to have possesses a mixed clast assemblage which was dominated by monocrystalline quartz, rock fragments and plagioclase. Other minor to accessory detrital components present include very fine-grained metasedimentary rock, polycrystalline quartz, opaque minerals, muscovite, amphibole, sericitised siltstone, mudstone, variably oxidised biotite, microcline, chlorite, variably hematised volcanic rock and tourmaline. Metasedimentary lithic fragments appear to have formed a common minor component within the sandstone.

Irregular patches of a turbid, yellow-brown clay cement and locally developed quartz overgrowths are present within this sandstone. Compaction resulted in localised pressure solution between adjacent quartz grains, and probably resulted in the main form of cementation within this sedimentary rock. However, traces of a colourless cryptocrystalline chloritic cement have also been recognised.

Collectors Number: SRK 197 **Registered Number:** N3009 **Location:** [NS 3042 1136] St. Murrays Quarry, 650 m southwest of St. Murrays **Rock Type:** medium- to coarse-grained, quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium- to coarse-grained, immature, very closely packed, hematised, matrix-poor, low porosity, moderately sorted, clast supported, quartzose, lithic-rich sandstone (quartzose litharenite). Detrital grains are angular to subangular in shape with a low to occasionally moderate sphericity. The shape of the more unstable clasts have been modified during compaction which resulted in the embayment of these grains against neighbouring more rigid clasts. This process was assisted by the very close packing of the sandstone.

The clast assemblage is dominated by lithic fragments along with subordinate amounts of monocrystalline quartz. The lithic clasts are altered making it difficult to identify the protolith. However, they appear to have been mainly composed of a very fine-grained sedimentary and/or volcanic rock. Some reco5gnisable lithologies forming lithic clasts within this sandstone include felsite, very fine-grained schist or phyllite, siltstone, psammite and quartzite. Minor to accessory detrital components include plagioclase, biotite, polycrystalline quartz, muscovite, opaque minerals, K-feldspar and hematised rock. Traces of a turbid, brown coloured (under plane polarised light) clay cement have been recognised within this sandstone. Compaction resulted in the kinking of detrital micas and localised pressure solution between quartzose grains. The very close packing of the sandstone locally makes it difficult to identify individual clast boundaries.

Collectors Number: SRK 198 **Registered Number:** N3010 **Location:** [NS 3130 1106] Black Glen, 500 m north-northwest of Drumellan **Rock Type:** altered/hornfelsed, fine-grained, lithic-rich sandstone **Formation:** ? Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine-grained, moderately sorted, very closely packed, immature, matrix poor, clast supported, lithic-rich, low porosity sandstone (litharenite). This sandstone has encountered a weak thermal overprint which resulted in the alteration of all the unstable detrital components to a turbid brown-green chloritic assemblage. This thermal event also resulted in the growth of minor amounts of orange-red to pale brown biotite. Biotite forms small, anhedral to granular looking flakes and probably formed due to the breakdown of lithic clasts and/or K-feldspar.

The original clast assemblage appears to have been dominated by unstable lithic fragments, feldspar and monocrystalline quartz. Although the unstable detrital components have been altered, the original grin shapes can locally still be recognised in plane polarised light. Other relict detrital components include polycrystalline quartz, apatite, opaque minerals and plagioclase. The preserved clasts are angular to subangular in shape with a low to moderate sphericity. A sedimentary lamination preserved within the sandstone is defined by a slight variation in modal quartz and opaque minerals. This compositional variation is also reflected in the modal proportions of later biotite which developed during thermal metamorphism. Dusty opaque oxides are common within this sample and were probably partially derived from the breakdown of unstable lithic fragments.

Collectors Number: SRK 203 **Registered Number:** N3011 **Location:** [NS 3145 1088] Black Glen, 275 m north-northwest of Drumellan **Rock Type:** medium-grained, relatively quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, moderately sorted, immature, closely to very closely packed, clast supported, matrix poor, low porosity, relatively quartzose, lithic-rich sandstone (quartzose litharenite). The clastic grains are angular to subangular in shape with a low to moderate sphericity. The grain shape of the unstable grains has locally been modified due to compaction and the very close packing of the sandstone. However, occasional subrounded clasts are also present. The shape of the quartzose clasts has also been altered due to grain boundary etching and pressure solution between adjacent grains. The clast assemblage is dominated by altered lithic fragments and monocrystalline quartz with minor plagioclase. the lithic clasts are mainly composed of a very fine-grained sedimentary and/or volcanic/tuffaceous rock. Other lithic components include siltstone, chert, felsite, very fine-grained basaltic rock, very fine-grained schist or phyllite, mudstone and possible amphibolite. Minor to accessory detrital components present include biotite, oxidised biotite, muscovite, microcline, chlorite, carbonate and polycrystalline quartz.

Traces of a patchily developed hematitic and colourless chloritic cements have been noted within this sandstone. The hematitic cement in fills intergranular pore spaces and forms coatings upon detrital grains. Traces of a later, apparently replacive, carbonate cement were also noted. Quartzose clasts are locally enclosed within variably developed quartz overgrowths.

Collectors Number: SRK 204 **Registered Number:** N3012 Location: [NS 3146 1018] Stonyfield Bridge, 400 m west-southwest of Fairy Knowe **Rock Type:** medium-grained, relatively quartzose, lithic-rich sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, massive, closely to very closely packed, matrix poor, clast supported, immature, relatively quartzose, lithic-rich sandstone (quartzose litharenite) which possesses a moderately well-developed pore filling hematitic cement. This hematitic cement gives the rock a ‘spotted’ or ‘mottled’ appearance under plane polarised light. Detrital grains are angular to subangular in shape with a low to occasionally moderate sphericity. Rare subrounded grains were also recorded within this sandstone.

The detrital assemblage is mainly composed of variably altered rock fragments and monocrystalline quartz. The lithic clasts are mainly composed of a very fine-grained sedimentary or tuffaceous rock. Recognisable lithic components include very fine-grained sandstone or siltstone, very fine-grained phyllite or schist, felsite, chert, psammite and biotite-schist. Minor to accessory detrital components include plagioclase, biotite, muscovite, K-feldspar, polycrystalline quartz, tourmaline and sericitised feldspar. Traces of a replacive carbonate cement are also present. Compaction resulted in localised pressure solution between adjacent quartzose grains and was probably accompanied by the development of quartz overgrowths on some clasts. Kinking of detrital micas also occurred during compaction.

Collectors Number: SRK 208 **Registered Number:** N3013 **Location:** [NS 3436 1083] stream, 450 m southwest of Pinmerry **Rock Type:** medium-grained, relatively quartzose, lithic-rich sandstone (quartzose litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, moderately to poorly sorted, immature, massive, closely to very closely packed, clast supported, matrix poor, relatively quartzose, lithic-rich sandstone (quartzose litharenite). This sample is distinguished from the previous thins section by the common occurrence of oxidised/hematised detrital biotite flakes.

Detrital grains are typically angular to subangular in shape with a low to occasionally moderate sphericity. However, rare subrounded grains are also present. The mixed clast assemblage is dominated by lithic fragments and monocrystalline quartz with minor amounts of plagioclase. The lithic clasts are mainly composed of volcanic and sedimentary rock fragments. Recognisable lithologies include very fine-grained schist, felsite, granitic rock, very fine-grained basaltic rock, plagioclase-amphibole-phyric andesite and siltstone. Minor to accessory detrital components include polycrystalline quartz, opaque minerals, muscovite, oxidised or hematised biotite, chlorite, microcline, garnet, apatite and chlorite pseudomorphs after detrital ferromagnesian mineral or rock.

Traces of a pale green chloritic cement have been recognised. However, pressure solution appears to have resulted in the main form of cementation within this sandstone. Pressure solution also resulted in localised grain boundary etching. Lithic clasts are locally embayed or indented against neighbouring more rigid quartzose grains. Metamorphic rock fragments are a common minor component within this sandstone. A weak preferred shape alignment of elongate grains has also been noted.

Collectors Number: SRK 216 **Registered Number:** N3014 **Location:** [NS 3294 1433] Culroy Burn, 125 m west of Minishant Bridge **Rock Type:** laminated, calcareous, lithic-rich sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to medium-grained, laminated, open packed, relatively quartzose, lithic-rich, matrix-poor, cement to locally clast supported, low porosity sandstone (litharenite). This sandstone is distinguished by the presence of a well-developed carbonate cement. The carbonate appears to be replacing the original matrix and unstable detrital components. Although altered, the ghost outlines of these replaced grains can still be recognised under plane polarised light by the mimetic growth of the secondary carbonate. The carbonate cement appears to be of a single generation.

Preserved detrital grains are angular to subangular in shape with a low sphericity. However, the shape of these clasts may have been modified during the development of the carbonate cement. Rare subrounded detrital grains have also been recorded. The clast assemblage was originally dominated by rock fragments and monocrystalline quartz. Recognisable lithologies include felsite, mudstone, siltstone, basaltic to andesitic rock, very fine-grained schist or phyllite, muscovite-rich metasedimentary rock, granitic rock, feldspathic volcanic rock, metabasalt, mylonitic rock and granite with well-developed micrographic intergrowth. Other minor to accessory detrital components present include muscovite, biotite, polycrystalline quartz, plagioclase, microcline, perthite, opaque minerals, Mg-chlorite, garnet and chlorite pseudomorphs after a ferromagnesian mineral or rock.

Traces of hematitic coatings or hematitic rim cement have also been noted. This cement pre-dates the formation of carbonate which forms the main mode of cementation within this sandstone.

Collectors Number: SRK 217 **Registered Number:** N3015 **Location:** [NS 3270 1439] Culroy Burn, 375 m west of Minishant Bridge **Rock Type:** fine- to medium-grained, calcareous, lithic-rich sandstone (litharenite) comparable to N3014 **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a fine- to medium-grained, poorly sorted, immature, open packed, low porosity, cement to locally clast supported, weakly laminated sandstone (litharenite). The lamination is defined by slight changes in grain size. Another distinctive feature of this sandstone is the common occurrence of aligned flakes of detrital biotite, muscovite and chlorite. These detrital phyllosilicates are shape-aligned parallel to the sedimentary lamination. The carbonate cement to the sandstone appear to have developed during a single generation, replacing the original matrix and unstable detrital components.

Detrital grains are angular to subangular in shape with a low to occasionally moderate sphericity. The shape of the clasts has locally, however, been modified during the development of the carbonate cement. Rare rounded grains are also present. The mixed detrital assemblage of this sandstone is dominated by lithic fragments, monocrystalline quartz and plagioclase. Recognisable lithologies include felsite, mudstone, siltstone, granitic rock and a very fine-grained tuffaceous to volcanic rock. However, in general the lithic clasts appear to have been mainly composed of a very fine-grained sedimentary and/or tuffaceous rock. Other minor to accessory detrital components include plagioclase, biotite, muscovite, chlorite, opaque minerals, garnet, perthite, zircon and polycrystalline quartz. Compaction resulted in the kinking of the detrital micas.

Collectors Number: SRK 218 **Registered Number:** N3016 **Location:** [NS 3254 1453] Culroy Burn, 550 m west-northwest of Minishant Bridge **Rock Type:** medium-grained, slightly calcareous, lithic-rich sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, poorly sorted, immature, clast supported to locally cement supported, closely to locally moderately packed, lithic-rich, low porosity,

massive sandstone (litharenite). A patchily developed carbonate cement results in the localised change in the texture of the sandstone, which becomes more open packed and cement supported. Carbonate appears to be replacing unstable detrital components, such as lithic fragments and feldspar. The cement appears to be of a single generation and formed by carbonate crystals up to 1.0 mm in length. these large crystals locally enclose the smaller detrital grains.

Detrital grains are angular, subangular to occasionally subrounded in shape with a low sphericity. The mixed clast assemblage is mainly composed of rock fragments and monocrystalline quartz. The lithic clasts are largely composed of a very fine-grained, altered volcanic rock. Recognisable lithologies include schist, felsite, siltstone, very fine-grained sandstone or coarse siltstone, sericitised rock or feldspar, metabasalt, very fine-grained schist or phyllite and hornblende phyric andesite. Other minor to accessory detrital components include plagioclase, biotite, muscovite, opaque minerals, garnet, tourmaline, polycrystalline quartz, myrmekite, chlorite and K-feldspar.

A cryptocrystalline chlorite and/or sericite rim cement apparently forms the main mode of cementation within this sandstone. A weak shape alignment of elongate clasts has been recognised within this sample. Compaction resulted in the kinking of detrital micas and localised pressure solution between adjacent quartzose grains. Biotite is variably altered to hematitic oxide. There is very little obvious matrix component within this sandstone.

Collectors Number: SRK 221 **Registered Number:** N3017 **Location:** [NS 3216 1441] Culroy Burn, 475 m east of Culroy Bridge **Rock Type:** medium-grained, lithic-rich sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium-grained, altered, closely packed, clast supported, immature, low porosity, lithic-rich, massive sandstone (litharenite). The sandstone possesses a patchily developed replacive carbonate cement which is associated with a hematitic stain.

Detrital grains are typically angular to subangular in shape with a low sphericity. However, rare subrounded grains are also present. The clast assemblage is dominated by altered lithic clasts and monocrystalline quartz. The lithic clasts appear to have originally mainly been composed of very fine-grained igneous rock fragments. These lithic fragments have now been replaced by a cryptocrystalline chloritic assemblage. The outline of these altered lithic clasts and there internal structure/texture is locally preserved by the mimetic growth of the alteration products. Minor to accessory detrital components include plagioclase, sericitised feldspar, biotite, muscovite, andesitic rock, polycrystalline quartz, cherty rock or felsite, metamorphic rock fragments, opaque minerals and very fine-grained schist or phyllite.

Compaction resulted in the kinking of detrital micas and localised pressure solution between quartzose grains. Traces of a colourless, cryptocrystalline chloritic or clay cement is developed within this sandstone.

Collectors Number: SRK 222 **Registered Number:** N3018 **Location:** [NS 3173 1439] Culroy Burn, 50 m southeast of Culroy Bridge **Rock Type:** laminated, medium- to coarse-grained, lithic-rich sandstone (litharenite) **Formation:** Swanshaw Formation, Lanark Group (Siluro-Devonian)

Description: This thin section is of a medium- to coarse-grained, poorly sorted, very closely packed, immature, lithic-rich, low porosity, grain supported sandstone (litharenite) which contains minor amounts of a replacive carbonate cement. This sandstone is characterised by the presence of a moderate to well developed preferred shape alignment of elongate detrital grains and detrital micas. This alignment occurs parallel to the sedimentary lamination; the latter being defined by a slight change in the grain size.

Detrital grains are angular, subangular to occasionally subrounded in shape with a low sphericity. However, the shape of the unstable grains has been modified during compaction, with the less rigid lithic clasts being embayed/indented against neighbouring more quartzose clasts. The mixed clast assemblage is dominated by altered, very fine-grained, possibly volcanic rock fragments and monocrystalline quartz. Minor to accessory detrital components present include plagioclase, polycrystalline quartz, biotite, muscovite and possible staurolite. Recognisable lithologies forming the lithic clasts include basalt, chert, metamorphic rock fragments, very fine-grained phyllite or schist, chloritic rock or serpentinite, hornblende phyric andesite, mudstone and felsite.

Traces of a cryptocrystalline chloritic or clay cement have been noted. This earlier developed chloritic cement is locally replaced by later secondary carbonate. Detrital biotite is a common minor component within this sandstone. These detrital biotite flakes are variably altered to hematitic oxide. Compaction resulted in the kinking of biotite and other detrital mica flakes.

2.6 BALLAGAN FORMATION

Collectors Number: SRK 86 **Registered Number:** N2967 **Location:** [NS 3250 0485] Balsaggart Glen, 450 m west-northwest of Balsaggart **Rock Type:** medium-grained, quartzose sandstone (quartz arenite) with a carbonate cement **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a medium-grained, slightly feldspathic, moderately to weakly poorly sorted, quartz-rich, clast supported, moderate to open packed sandstone (quartz-arenite). It possess a well-developed carbonate cement which is composed of 0.3 to 0.5 mm long poikilitic crystals which enclose the smaller detrital grains. This carbonate cement is secondary in origin and appears to be replacing the unstable detrital components, primary matrix and any earlier cement (if present). The main form of cementation prior to the development of the carbonate cement occurred as a result of pressure solution and grain boundary etching of the quartzose clasts. Traces of an early, apparently poorly developed quartz rim cement and clay coatings upon some detrital grains have also been noted. Rare faceted quartz overgrowths have been recognised.

Detrital grains are angular to subrounded in shape with a low to moderate sphericity. Rare well-rounded clasts have also been recorded. However, the shape of these detrital grains has been modified during pressure solution and the later development of the carbonate cement. The clast assemblage is dominated by monocrystalline quartz with minor feldspar and polycrystalline quartz. Other minor to accessory detrital components include plagioclase, microcline, perthite,

altered siltstone/mudstone, tuffaceous volcanic rock, opaque minerals, oxidised biotite, chlorite, muscovite and felsite.

Collectors Number: SRK 132 **Registered Number:** N2985 **Location:** [NS 3008 0169] small quarry, 1125 m west-northwest of Barony Hill **Rock Type:** slightly feldspathic, quartz-rich sandstone (quartz-arenite) **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a fine-grained, matrix-poor, moderately sorted, relatively mature, closely packed, clast supported, massive, slightly feldspathic, quartz-rich sandstone (litharenite). This sandstone possesses a patchily developed hematitic rim cement which forms coatings on detrital grains and a lining to preserved primary intergranular porosity. Detrital grains are angular to subrounded in shape with a low to moderate sphericity. However, the shape of the clasts has been modified due to etching of clast grain boundaries in response to pressure solution. The latter results in the main mode of cementation within this sandstone.

The clast assemblage is dominated by monocrystalline quartz with subordinate to minor feldspar. Quartz varies from strained to unstrained and locally possesses a well developed undulose extinction. Minor to accessory detrital components include microcline, plagioclase, cryptocrystalline quartz or cherty rock, zircon, opaque minerals, chlorite, tourmaline, muscovite, very fine-grained metasedimentary rock, felsite and mudstone. Compaction resulted in the flattening and plastic deformation of the occasional to rare mudstone lithic clasts included within this sandstone.

Collectors Number: SRK 147 **Registered Number:** N2989 **Location:** [NS 3206 0297] Lady Burn, 650 m northwest of Blair Farm **Rock Type**: fine-grained, calcareous, quartz-rich sandstone (quartz-arenite) with granule sized clasts of carbonate replaced sandstone (cornstone) **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a fine- to medium-grained, poorly sorted, calcareous, quartz-rich, relatively mature, open to very open packed, cement supported sandstone (quartz-arenite) which contains very coarse sand to granule sized clasts of carbonate replaced sandstone (cornstone). These cornstone clasts are distinguished from the remainder of the sandstone by their much darker brown colour under plane polarised light and finer grain size. The type of carbonate minerals present is unknown as this thin section is unstained.

Detrital grains within this calcareous quartz arenite are typically subangular to subrounded in shape with a low to moderate sphericity. However, occasional well rounded clasts are also present. The shape of the detrital grains has locally been modified due to grain boundary etching during the development of the carbonate cement. The clasts are mainly composed of monocrystalline quartz. Quartz ranges from strained to unstrained and possesses a variably developed undulose extinction. Other minor to accessory detrital components include microcline, polycrystalline quartz, opaque minerals, zircon, chalcedonic quartz and tourmaline.

The cornstone clasts are irregular in shape due to pressure solution and embayment against neighbouring more rigid quartzose clasts. A rarely developed isopachous rim cement has been noted coating some detrital grains. However, the main carbonate cement appears to be of a single generation.

Collectors Number: SRK 151 **Registered Number:** N2990 **Location:** [NS 3186 0298] Lady Glen, 800 m northwest of Blair Farm **Rock Type:** calcareous, medium-grained, quartz-rich sandstone (quartz-arenite) **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a medium-grained, poorly sorted, relatively mature, open packed, cement to locally clast supported, quartz-rich, calcareous sandstone (quartz-arenite). This sandstone possesses a well-developed cement composed of coarse crystalline carbonate which locally includes preserved detrital grains. Traces of an earlier clay and/or sericitic rim cement has also been noted. This early formed cement is locally overgrown or replaced by carbonate.

Detrital grains are angular to subrounded in shape with a low sphericity. Occasional well rounded grains are also present within this sandstone. Grain shape has, however, locally been modified due to grain boundary etching which accompanied the development of the carbonate cement. Detrital grains are mainly composed of monocrystalline quartz. Quartz is strained to unstrained with a variably developed undulose extinction. Other minor to accessory detrital components include microcline, chalcedonic quartz, polycrystalline quartz, plagioclase and cherty rock.

Localised pressure solution between adjacent quartz grains has been recorded within this sandstone. The carbonate cement appears to be of a single generation replacing the earlier developed cement and/or matrix.

Collectors Number: SRK 152 **Registered Number:** N2991 **Location:** [NS 3172 0305] Lady Glen, 950 m northwest from Blair Farm **Rock Type:** calcareous, medium-grained, quartz-rich sandstone (quartz-arenite) **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a medium-grained, moderately to well sorted, relatively mature, calcareous, closely packed, clast supported, quartz-rich sandstone which possesses a well-developed intergranular carbonate cement. This cement appears to be of a single generation. The type of carbonate minerals present are unknown as this thin section is unstained.

Detrital grains are subrounded to rounded in shape with a low to moderate sphericity. However, the shape of these clasts has been locally modified due to grain boundary etching as a result of pressure solution between quartzose clasts. Elsewhere, the development of the carbonate cement also appears to have resulted in the localised modification of detrital grain shape. The clast assemblage is dominated by monocrystalline quartz with subordinate fragments of a very fine-grained carbonate rock or limestone. These originally rounded to well rounded limestone clasts are locally embayed against neighbouring more rigid quartzose grains. Internally the carbonate lithic fragments are massive and exhibit a dusty brown colour under plane polarised light. Quartz is strained to unstrained and possesses a variably developed undulose extinction. Minor to accessory detrital components present within the sandstone include microcline, perthite, polycrystalline quartz, plagioclase, felsite, cherty rock, garnet, sheared polycrystalline quartz, ?rutile, apatite, opaque minerals and muscovite.

The earliest form of cementation within the sandstone occurred due to pressure solution between quartzose clasts. This was followed by the later development of the replacive carbonate cement. Traces of quartz overgrowths and a pale green-grey chloritic or clay cement or matrix were also noted.

Collectors Number: SRK 154a **Registered Number:** N2992 **Location:** [NS 3135 0323] Lady Glen, 775 m south-southeast from Ladyburn Bridge **Rock Type:** laminated, slightly calcareous, fine-grained, quartz-rich sandstone (quartz-arenite) **Formation:** Ballagan Formation (Carboniferous)

Description: This thin section is of a fine-grained, laminated, quartz-rich, relatively mature, closely packed, clast supported, slightly calcareous sandstone (quartz-arenite). The sedimentary lamination is defined by thin, red-brown coloured (under plane polarised light) clay or mud-rich laminae. Small mudstone lithic clasts are present elsewhere within the sandstone layers and probably represent rip-up clasts eroded from the underlying muddy partings. Compaction led to localised pressure solution along quartzose grain boundaries and the earliest phase of cementation within this sandstone. This cement pre-dated the development of the minor to trace amounts of replacive carbonate.

Detrital grains are mainly composed of monocrystalline quartz. Other minor to accessory detrital components include mudstone, plagioclase, microcline, opaque minerals, zircon, muscovite and chlorite. Carbonate appears to be replacing unstable lithic clasts and minor matrix component within this sandstone.

Collectors Number: SRK 156 **Registered Number:** N2993 **Location:** [NS 3117 0386] Lady Burn, 125 m south-southwest of Ladyburn Bridge **Rock Type:** calcareous, medium- to coarse-grained, quartz-rich sandstone (quartz-arenite) **Formation:** ?Ballagan Formation (Carboniferous)

Description: This thin section is of a medium- to coarse-grained, open packed, clast to locally cement supported, relatively mature, moderately to poorly sorted, quartz-rich, calcareous sandstone which contains occasional or rare granule to small pebble sized lithic clasts.

Detrital grains are subrounded to rounded in shape with a moderate to low sphericity. However, the shape of the clasts has been modified due to pressure solution and the development of quartz overgrowths. This was then followed by grain boundary etching during the development of the carbonate cement. This intergranular carbonate cement is apparently of a single generation and composed of fine- to medium-grained crystalline/sparry carbonate. The type of carbonate minerals present is uncertain as this thin section is unstained.

Detrital grains are mainly composed of monocrystalline quartz with minor polycrystalline quartz, feldspar and lithic fragments. Recognisable lithologies forming the lithic clasts include mudstone, hematised mudstone, very fine-grained sandstone, schist or phyllite, quartzite and deformed vein quartz. Other minor to accessory detrital components present include plagioclase, opaque minerals, chlorite, sericitised feldspar, K-feldspar, felsite/cherty rock and microcline.

Traces of an early polycrystalline, intergranular quartz cement and weak alignment of elongate clasts have been recorded within this sandstone. Compaction resulted in the embayment of unstable lithic grains against neighbouring more rigid quartzose grains.

2.7 KINNESSWOOD FORMATION

Collectors Number: SRK 93 **Registered Number:** N2968 **Location:** [NS 3382 0382] Kirkbride Glen, 50 m west of Kirkbride **Rock Type:** coarse-grained, calcareous, pebbly quartzose sandstone (quartz arenite) **Formation:** Kinnesswood Formation (Carboniferous)

Description: This thin section is of a coarse-grained, poorly to very poorly sorted, open to very open packing, cement supported, laminated or bedded, quartzose calcareous sandstone with a well developed replacive carbonate cement. The sedimentary lamination or bedding is defined by the variation in grain size, with one layer being rich in granule to small pebble sized clasts. These larger detrital grains are subrounded to rounded in shape with a low sphericity. They are mainly composed of very fine-grained to micritic carbonate rock or carbonate replaced sandstone or sandy limestone. Monocrystalline and polycrystalline quartz were also noted forming large clasts.

The sand-grade detrital component to the sandstone is composed of angular to subrounded clasts which possess a low to moderate sphericity. However, the grain shape of these clasts has locally been modified during the development of the carbonate cement, the latter resulting in grain boundary etching. The clast assemblage is dominated by monocrystalline quartz with subordinate to minor feldspar (plagioclase and microcline) and minor lithic clasts. The lithic clasts are composed of a very fine-grained possibly tuffaceous rock, carbonate replaced siltstone and mudstone. Other minor to accessory detrital components include opaque minerals, perthite, polycrystalline quartz, oxidised biotite, chlorite and muscovite.

Elongate detrital grains display a weakly developed preferred shape alignment parallel to bedding. The cement is typically composed of fine- to medium-grained, crystalline (sparry) carbonate. However, a fine-granular isopachous rim cement is locally developed, suggesting that there are at least two generation of carbonate cement within this sandstone.

Collectors Number: SRK 94 **Registered Number:** N2969 **Location:** [NS 3378 0300] sheepfold, 275 m south-southwest of Shaw's Knowe **Rock Type:** medium-grained, calcareous sandstone (quartz arenite) **Formation:** Kinnesswood Formation (Carboniferous)

Description: This thin section is of a medium-grained, moderate to poorly sorted, relatively mature, quartz-rich, calcareous sandstone (quartz-arenite). The sandstone is clast to very locally cement supported with a moderate to open packed texture. Occasional granule to small pebble sized clasts are composed of carbonate replaced mudstone, siltstone and a polycrystalline carbonate rock (? limestone).

Detrital grains are subangular to rounded in shape with a low to moderate sphericity. Grain shape has, however been modified due to the development of the carbonate cement. The clast

assemblage is dominated by monocrystalline quartz with minor to subordinate feldspar (plagioclase and microcline) and polycrystalline quartz. Other minor to accessory detrital components present include opaque minerals, muscovite, very fine-grained ? tuffaceous rock, very fine quartzose sandstone, felsite, staurolite and possible rutile. The lithic clasts are partially degraded and replaced by carbonate making it difficult to identify the protolith to these clasts.

Thin, early clay coatings, or rim cement, are locally/rarely preserved on some detrital grains. The earliest mode of cementation within this sandstone occurred in response to pressure solution, leading to grain boundary etching/suturing. No obvious primary matrix component has been observed/preserved within this sandstone.

Collectors Number: SRK 126a **Registered Number:** N2982 **Location:** [NS 3135 0177] Toddy Burn, 400 m north-northeast of Barony Hill **Rock Type:** fine-grained, massive limestone **Formation:** Kinnesswood Formation (Carboniferous)

Description: This thin section is of a fine-grained, massive, crystalline/recrystallised limestone. No obvious sedimentary structures or bioclastic material have been recognised within this limestone. The rock consists of angular to rounded patches or fragments of fine-grained crystalline limestone enclosed within a network of coarser grained carbonate. The latter may have formed to in fill fractures. Rounded to locally faceted quartz grains are also present. Quartz is strained to unstrained and possesses a variably developed undulose extinction. Quartz may represent either detrital grains or alternatively authogenic crystals. The type of carbonate minerals present within this limestone are unknown as this thin section is unstained. Occasional styolitic pressure solution seams are developed.

Collectors Number: SRK 140 **Registered Number:** N2987 **Location:** [NS 3317 0273] bank side, 100 m southeast of Culloch Knowes **Rock Type:** highly altered, carbonate replaced, fine-grained sandstone **Formation:** Kinnesswood Formation (Carboniferous)

Description: This thin section is of a highly altered, carbonate replaced, originally fine-grained sandstone in which the bulk of the unstable detrital components (lithic clasts, feldspar) and matrix have been replaced by fine-grained, inequigranular carbonate. The type of carbonate minerals present are uncertain as this thin section has not been stained. Carbonate replacement has largely resulted in the overprinting of the original clastic texture of the rock. The carbonate contains irregular pockets of hematitic oxide which locally result in the staining of the carbonate. Relict detrital grains are mainly composed of monocrystalline quartz. These are isolated within the carbonate resulting in an open packed cement supported texture to the rock. Other minor to accessory, relict detrital components present include polycrystalline quartz, hematised mudstone, felsite, cherty rock, plagioclase, opaque oxide and chlorite. The rock is cut by impersistant, irregular carbonate veinlets.

2.8 IGNEOUS ROCKS

Collectors Number: SRK 97 **Registered Number:** N2971 **Location:** [NS 3418 0266] Balsaggart Burn, 700 m south-southeast of Shaw's Knowe **Rock Type:** xenolithic, pilotaxitic,

plagioclase-amphibole microporphyritic dacite (Old Red Sandstone intrusive rock) **Symbol:** flplhbR^{D}

Description: This thin section is of a fine-grained, inequigranular, feldspathic, hypocrystalline dacitic rock with a well-developed pilotaxitic fabric within the groundmass. This dacitic rock comprises the assemblage feldspar, quartz, opaque oxides with accessory apatite. Alteration resulted in the development of a very fine-grained assemblage of carbonate and chlorite.

The pilotaxitic fabric present within the groundmass is defined by shape aligned feldspar laths. The shear bands which deform this foliation are considered to have formed in response to ductile shearing which occurred during emplacement. Feldspar is twinned and is a dusty pinky brown colour under plane polarised light. Traces of interstitial to intersertal quartz are present within the groundmass. Feldspar phenocrysts range up to *c*. 2.5 mm in length, but are typically less than 1.5 mm in size. These phenocrysts are wrapped by the pilotaxitic fabric present within the groundmass. Pseudomorphs after small amphibole microphenocrysts are composed of very fine-grained opaque oxide set within a cryptocrystalline chloritic mosaic.

Collectors Number: SRK 99 **Registered Number:** N2972 **Location:** [NS 3459 0221] Balsaggart Burn, 600 m north of Calschrie Hill **Rock Type:** feldspar-biotite-?amphibole microporphyritic dacite (Old Red Sandstone intrusive rock) **Symbol:** fbmiR^{D}

Description: This thin section is of a fine-grained, inequigranular, altered, massive, hypocrystalline, possibly originally glassy, microporphyritic and weakly glomerophyric dacite. This dacitic rock comprises the assemblage feldspar, biotite, opaque oxide and quartz with accessory apatite and zircon. Alteration resulted in the development of the assemblage chlorite, carbonate, clay minerals and albitic plagioclase.

Phenocrysts are mainly composed of altered feldspar and biotite with occasional pseudomorphs after possible amphibole (or ? pyroxene). Feldspar is variably altered to, or pseudomorphed by carbonate, clay minerals and albitic plagioclase. The original phenocrysts were twinned, with anhedral to subhedral feldspar occurring as single, isolated microphenocrysts or glomerophyric clusters of several crystals. Minor rounding of feldspar phenocrysts, due to partial resorption, has been recorded. Biotite is fresh and typically occurs as anhedral to subhedral flakes. However, occasional to rare euhedral biotite crystals have also been noted. Biotite possesses a sweeping to undulose extinction and ranges up to 2.0 mm in length.

The fine-grained groundmass to this dacite is mainly composed of dusty looking (under plane polarised light) feldspar, but also contains small irregular patches of very fine-grained to cryptocrystalline quartz. These quartz patches are interstitial to intersertal to feldspar. Minor replacement of the groundmass by carbonate was also noted.

Collectors Number: SRK 100 **Registered Number:** N2973 **Location:** [NS 3493 0215] knoll, 650 m northeast of Clauchrie Hill **Rock Type:** pilotaxitic, plagioclase-biotite-microporphyritic dacite (Old Red Sandstone intrusive rock) **Symbol:** flplbmiR^{D}

Description: This thin section is of a fine-grained, microporphyritic to macroporphyritic, pilotaxitic, hypocrystalline dacite which is composed of an inequigranular assemblage of plagioclase, K-feldspar, biotite and quartz with minor to accessory opaque oxides, apatite and zircon. Alteration resulted in the development of chlorite (± opaque oxide). The groundmass possesses weakly to moderately developed pilotaxitic fabric defined by variably shape aligned feldspar laths. This fabric was observed wrapping around the phenocrysts. The groundmass is mainly composed of feldspar with trace amounts of biotite, opaque oxide and interstitial quartz.

Phenocrysts are mainly composed of plagioclase and biotite. Plagioclase forms twinned, subhedral to euhedral crystals which are prismatic to lath-shaped. They typically occurs as large (up to 3.5 mm in length) isolated crystals set within the finer grained groundmass. However, glomerophyric clusters of several plagioclase crystals were also noted within this dacite. Biotite forms anhedral to euhedral flakes which exhibit only minor alteration to chlorite. Biotite is locally kinked. Rare hematitic pseudomorphs after possible hornblende microphenocrysts are also present.

Collectors Number: SRK 158 **Registered Number:** N2994 **Location:** [NS 3396 1399] bank side of River Doon, 750 m northwest of woodland **Rock Type:** highly altered, olivine-pyroxene-plagioclase-microporphyritic basalt, possibly camptonitic **Age:** Permian **Symbol:** opmiB/L^{C}

Description: This thin section is of a fine-grained, highly altered, microporphyritic, amygdaloidal basalt which comprises and inequigranular assemblage of chlorite, albitic plagioclase, serpentine, opaque oxide, biotite and analcime. Traces of a zeolite mineral are also present infilling the amygdales along with carbonate and chlorite. The presence of biotite and analcime in the mineral assemblage along with olivine and pyroxene suggest that it may be camptonitic in nature.

Phenocrysts are mainly composed of pseudomorphs after anhedral to euhedral olivine and pyroxene. Rare pseudomorphs after plagioclase phenocrysts are also present. All phenocryst phases are totally replaced by a fine- to very fine-grained assemblage of carbonate, chlorite and, in some cases, serpentine. The phenocrysts originally occurred as single isolated crystals as well as clusters of several small microphenocrysts.

The groundmass is very fine-grained and composed of randomly orientated, elongate to needle-like albitised plagioclase laths, opaque and chlorite pseudomorphs after pyroxene and needles of green-brown biotite. The remaining interstitial to intersertal phases, possibly including glass, have been replaced by pale green cryptocrystalline chlorite. Carbonate preferentially occurs within the pseudomorphs after the phenocrysts and is possibly replacing earlier developed chlorite. Chlorite may locally contain dusty looking inclusions of opaque oxide.

Collectors Number: SRK 159 **Registered Number:** N2995 **Location:** [NS 3396 1399] bank side of River Doon, 750 m northwest of woodland **Rock Type:** olivine-pyroxene-microporphyritic alkali basalt or camptonite **Age:** Permian **Symbol:** opmiB/L^{C}

Description: This thin section is of a fine-grained, originally glassy, holocrystalline, amygdaloidal, xenolithic or autobrecciated, weakly altered basalt or camptonitic basalt which comprises and inequigranular assemblage of clinopyroxene, olivine, plagioclase and opaque

minerals with minor analcime, biotite, amphibole and zeolites. Alteration resulted in the development of a fine-grained assemblage of chlorite, carbonate, opaque oxides, serpentine and epidote.

Phenocrysts are composed of anhedral to subhedral, equant olivine and clinopyroxene. Olivine is variably altered to, and pseudomorphed by serpentine, chlorite and carbonate; the latter replacing the earlier developed phyllosilicates. The pseudomorphs after olivine are enclosed within a rim of opaque with thin seams of opaque also preserving fractures within the crystals. Clinopyroxene is twinned and zoned, and varies from pale brown to pinky brown in colour suggesting that its a Ti-augite in composition. Olivine phenocrysts occur in distinct areas within the rock highlighted by patchy alteration. This patchy alteration and distribution of olivine results in a xenolithic or brecciated appearance to the rock. Amygdales are composed of the assemblage analcime, zeolite, chlorite and carbonate.

The fine-grained, originally glassy groundmass is composed of randomly orientated to weakly aligned, elongate to needle-like plagioclase laths. Interstitial, granular pink-brown coloured Ti-augite is locally overgrown by minor biotite and kaersutite amphibole. The remaining interstitial to intersertal areas are filled by a pinky grey (under plane polarised light) mesostasis. Anhedral opaque minerals are a common minor phase within the groundmass.

Collectors Number: SRK 176 **Registered Number:** N3004 **Location:** [NS 3421 1298] bank side of River Doon, 225 m northeast of Cassillis House **Rock Type:** highly altered, olivine-pyroxene-microporphyritic basaltic rock **Formation:** Carrick Volcanic Formation, Lanark Group (Siluro-Devonian) **Symbol:** opmiB

Description: This thin section is of a fine-grained, inequigranular, hypocrystalline, highly altered (chloritised and hematised), microporphyritic, massive, basaltic rock which is composed of the assemblage albitic plagioclase, chlorite, bowlingite, carbonate and hematitic oxide. Phenocrysts appear to have been mainly composed of olivine with minor pyroxene and, possible, plagioclase. Olivine is completely pseudomorphed. These pseudomorphs comprise a core of carbonate, bowlingite and/or chlorite, enclosed within a rim of opaque oxide. In contrast, pseudomorphs after pyroxene are completely composed of carbonate.

The groundmass is mainly composed of randomly orientated, albitised plagioclase laths. Plagioclase forms anhedral, twinned crystals. The interstitial to intersertal phases have been completely replaced by yellow-green to brown chlorite and carbonate. This chloritic assemblage is probably replacing primary intergranular pyroxene and glass. No relict ferromagnesian minerals have been recognised within this highly altered basaltic rock. Other minor to accessory phases present include epidote and a dusty brown coloured (under plane polarised light) mesostasis.

Collectors Number: SRK 177 **Registered Number:** N3005 **Location:** [NS 3423 1299] bank side of River Doon, 250 m northeast of Cassillis House **Rock Type:** amygdaloidal, plagioclase-pyroxene-microporphyritic basalt or basaltic andesite **Formation:** Carrick Volcanic Formation, Lanark Group (Siluro-Devonian) **Symbol:** plpmiB/A^B

Description: This thin section is of a fine-grained, inequigranular, hypocrystalline, microporphyritic, amygdaloidal, microporphyritic, brecciated, weakly foliated basalt or basaltic andesite. The rock is characterised by the presence of an irregular fracture filled by finely laminated clast overlain by silt. The clay present within this fracture possesses a weakly developed plasmic fabric which occurs parallel to the lamination. This fabric is observed under crossed polarised light and is defined by the optical alignment of the clay plasma. The remaining voids within the fracture after the development/deposition of the sediment in fill were filled by an outer rim of cryptocrystalline radial fibrous quartz enclosing a core of chlorite. The cryptocrystalline chlorite within the core of the voids is locally partially replaced by secondary carbonate. Overall texture or structure of the fill of the fractures is comparable to a geopetal in fill, suggesting that the sediment was deposited by water percolating along the fracture. Brecciation/fracturing of the rock may have occurred during extrusion, possibly the sample is of the rubbly top of a lava flow.

The basalt is composed of randomly orientated to locally aligned plagioclase laths set in a very fine-grained, originally glassy, mesostasis. The aligned plagioclase laths define a patchily developed pilotaxitic fabric. Twinned plagioclase laths are variably altered to cryptocrystalline chlorite and carbonate. Plagioclase was also noted forming small, anhedral to weakly subhedral microphenocrysts. These The mesostasis is rich in inclusions of very fine-grained to dusty looking opaque minerals. Also present are chlorite and bowlingite pseudomorphs after anhedral to subhedral pyroxene crystals. Amygdales are composed of quartz, chlorite and carbonate, with the latter replacing the earlier formed chlorite. Chlorite pseudomorphs after rounded, anhedral pyroxene microphenocrysts are also present within this basaltic rock. These phenocrysts occur as single isolated crystals as well as glomerophyric clusters of 2 to 3 microphenocrysts.

Collectors Number: SRK 183 **Registered Number**: N3006 **Location:** [NS 3352 1490] flood plain of River Doon, 450 m west of Monkwood **Rock Type:** altered, coarse-grained alkaline basalt or fine-grained microgabbro **Symbol:** B^A or D^A

Description: This thin section is of a coarse-grained, anhedral to weakly subhedral granular, holocrystalline, altered, ophitic, aphyric basalt or fine-grained microgabbro. The rock is mainly composed of randomly orientated anhedral to subhedral plagioclase laths which forma relatively open crystal framework. Plagioclase is twinned and locally simply zoned, and formed elongate to prismatic crystals which range up to approximately 1.2 mm in length. Plagioclase exhibits minor alteration to chlorite along fractures. Clinopyroxene occurs intergranular to plagioclase and possesses a distinctive pinky brown colour (under plane polarised light); suggesting that is a Ti-augite in composition. The presence of possible Ti-augite within the assemblage suggests that this basalt/microgabbro is alkaline in character. Pyroxene forms anhedral granular, weakly pleochroic crystals which contain inclusions opaque oxide. A weakly developed zonation was also noted in some pyroxene crystals. Another intergranular ferromagnesian mineral (possibly olivine) has been completely pseudomorphed by yellow-green, mesh-textured bowlingite. The remaining interstitial to intersertal phases have been replaced by cryptocrystalline chlorite. Traces of secondary carbonate, replacing earlier formed chlorite, were also noted. Anhedral to subhedral opaque (?magnetite) crystals are a common minor phase within this basaltic rock. Accessory apatite is also present.

Collectors Number: SRK 195 **Registered Number:** N3008 **Location:** [NS 3040 1179] Brockloch Burn, 500 m west-southwest of St. Murrays **Rock Type:** altered, very fine-grained, quartz-bearing tholeiitic basalt **Symbol:** qB^T

Description: This thin section is of a very fine-grained, aphyric to weakly microporphyritic, hypocrystalline, altered, massive, weakly amygdaloidal, quartz-bearing tholeiitic basalt. This basalt contains small rounded amygdales composed of carbonate. Alteration resulted in the development of a fine-grained to cryptocrystalline, inequigranular assemblage of chlorite, carbonate and opaque oxide.

The bulk of the rock is composed of fine- to very fine-grained, randomly orientated to radially arranged, elongate plagioclase laths. Plagioclase forms anhedral, twinned crystals with the larger microphenocrysts displaying a simple zonation. Feldspar exhibits minor alteration to chlorite and carbonate. The interstitial to intersertal areas are mainly filled by a dusty looking (under plane polarised light) mesostasis which contains numerous very fine-grained granules of opaque oxide. This mesostasis is variably replaced by chlorite. Patchy carbonate alteration within this basaltic rock appears to have centred/nucleated upon clusters of plagioclase crystals. Trace amounts of quartz occurs as an interstitial phases along with opaque minerals.

3 Glossary

3.1 TERMINOLOGY USED TO DESCRIBE IGNEOUS ROCKS

Crystallinity – (a) ***holocrystalline***, an igneous rock composed of 100% crystals; (b) ***holohyaline***, an igneous rock composed of 100% glass; and (c) ***hypocrystalline***, intermediate between the two end-members and can be described more precisely by stating the relative proportions of crystals and glass.

Microcrystalline – crystals can be identified with a petrological microscope. Crystals only just large enough to show polarisation colours (less than 0.01 mm in size) are called microlites.

Cryptocrystalline – crystals are too small to be identified even with the petrological microscope.

Grain size – (a) coarse-grained, crystals > 5.0 mm in size; (b) medium-grained, crystals 1.0 to 5.0 mm in size; (c) fine-grained, crystals < 1.0 mm in size.

Equigranular – all crystals are approximately the same size.

Inequigranular – crystals of substantially different grain size. Common variety, porphyritic texture consists of large crystals of a particular mineral or minerals set in a finer grained groundmass. ***Porphyritic texture*** can be subdivided into: (a) ***microporphyritic***, phenocrysts equal

to or less than 2.0 mm in size; and (b) ***macroporphyritic***, phenocrysts greater than 2.0 mm in size.

Seriate texture – continuous range in crystal size of principal minerals.

Trachytic texture – sub-parallel alignment of microcrystalline feldspar in the groundmass of a holocrystalline or hypocrystalline rocks. Sub-divided into ***pilotaxitic*** texture and ***hyalopilitic*** texture depending on whether the material between the feldspar is crystalline or glassy. Trachytoid texture, alignment of tabular, bladed or prismatic crystals which is visible to the naked eye. The terms flow and fluxion texture are sometimes used as synonyms for trachytic and trachytoid textures. However, they are best avoided due to their genetic implications.

Andesite – An intermediate volcanic rock, usually porphyritic, consisting of plagioclase (frequently zoned from labradorite to oligoclase), pyroxene, hornblende and/or biotite.

Basalt – A volcanic rock consisting essentially of calcic plagioclase and pyroxene. Olivine and minor feldspathoids may also be present.

Basaltic andesite – A volcanic rock with plagioclase compositions expected for andesites but containing ferromagnesian minerals more commonly found in basalts.

Dacite – A volcanic rock composed of quartz and sodic plagioclase with minor amounts of biotite and/or hornblende and/or pyroxene.

Gabbro – A coarse-grained plutonic rock composed essentially of calcic plagioclase, pyroxene and Fe-oxides. If olivine is an essential constituent it is referred to as an olivine-gabbro – if quartz, a quartz-gabbro.

Dolerite – A rock of intermediate grain size between a basalt and gabbro (i.e. synonym for microgabbro), and composed of essentially plagioclase, pyroxene and opaque minerals. Often contains an ophitic texture. If olivine is present may be called an olivine-dolerite; if quartz, a quartz-dolerite.

Felsite – A rock term initially used for the microcrystalline groundmass of porphyries. Now commonly used for microcrystalline rocks of granitic composition (i.e. dacite to rhyolite).

Rhyolite – A collective term for silicic volcanic rocks consisting of phenocrysts of quartz and K-feldspar, often with minor plagioclase and biotite, in a microcrystalline or glassy groundmass.

Olivine-basalt – A commonly used term for a basalt containing olivine as an essential constituent.

Granite – A medium- to coarse-grained plutonic rock consisting essentially of quartz, K-feldspar and plagioclase in variable amounts usually with hornblende and/or biotite.

Accessory – A minor constituent of rocks which is present only in small amounts, for example the minerals apatite, zircon, titanite.

3.2 TERMINOLOGY USED TO DESCRIBE METAMORPHIC ROCKS

Cleavage – A sub-parallel set of closely spaced approximately planar surfaces produced during rock deformation. Defined by the preferred alignment of platy or elongate mineral grains (usually phyllosilicate minerals such as muscovite, biotite, chlorite).

Corona or reaction rim – A monomineralic or polymineralic rim totally surrounding a core of another mineral phase. It typically represents an arrested reaction between the core phase and other components within the rock.

Decussate structure – A term used to describe interlocking, randomly orientated, elongate, prismatic or subhedral crystals, generally of one mineral phase.

Gneiss – A coarsely banded high-grade metamorphic rock consisting of alternating, mineralogically distinct layers.

Granoblastic texture – An aggregate consisting of equidimensional, typically rounded to anhedral crystals of approximately equal size.

Hornfels – A hard, fine- to medium-grained granoblastic rock produced by high-grade contact metamorphism.

Poikiloblast – A term used to describe porphyroblasts with abundant mineral inclusions.

Porphyroblast – A metamorphic mineral (e.g. garnet) that has grown to much larger size than the minerals of the surrounding matrix.

Porphyroblastic – A term used to describe a metamorphic rock containing large porphyroblasts within a finer grained matrix.

Post-tectonic growth – Growth of minerals or parts of a mineral which occurred after deformation had ceased.

Pressure shadow – A region of low strain developed immediately adjacent to a rigid or competent object in a rock (e.g. a garnet porphyroblast).

Pre-tectonic growth – Mineral growth before deformation has occurred.

Pseudomorph – A mineral or aggregate of minerals having taken the form/shape of another mineral phase that it/they have replaced.

3.3 TERMINOLOGY USED TO DESCRIBE SEDIMENTARY ROCKS

Grain Size – (a) clay < 0.0039 mm in size; (b) silt, 0.0039 to 0.0625 mm in size; (c) fine sand, 0.0625 to 0.25 mm in size; (d) medium sand, 0.25 to 0.5 mm in size; (e) coarse sand, 0.5 to 1.0 mm in size; (f) very coarse sand, 1.0 to 2.0 mm in size; (g) granules 2.0 to 4.0 mm in size; (h) pebbles 4.0 to 64 mm in size.

Roundness – Describes the smoothness of the surface of a grain. The terms well-rounded, rounded, subrounded, subangular, angular, very angular are used to describe the increasingly angular/irregular/rough nature of the surface of detrital grains.

Sphericity – Describes the how closely a detrital grain approximates to a sphere. The terms low sphericity, moderate sphericity and high sphericity are used to describe how spherical (ball-like) the detrital grains are.

Sorting – Well sorted describes a deposit in which all the detrital grains are of approximately uniform size. In reality most fragmentary deposits contain a range of grain sizes and can be described as moderately sorted, poorly sorted or in extreme cases unsorted.

Packing – Describes, as the term suggests, how closely the individual detrital grains are packed together within a fragmentary deposit. The term closely packed is used where all the grains are in contact and there is very little obvious matrix or cement; moderately packed and open packed are used with an increase in the porosity, matrix and/or cement.

Clast supported – Describes a fragmentary deposit where all the detrital grains are in contact.

Matrix supported – Describes a fragmentary deposit where the detrital grains are, to varying degrees, isolated/supported within a finer grained matrix.

Cement supported – Describes a fragmentary deposit where the detrital grains are, to varying degrees, isolated/supported within the cement.

Cement – The material bonding the fragments of clastic sedimentary rocks together and which was precipitated between the grains after deposition.

Porosity – The volume of voids expressed as a percentage of the total volume of the sediment or sedimentary rock.

Matrix – Material, usually clay minerals or micas, forming a bonding substance to grains in a clastic sedimentary rock. The matrix material was deposited with the other grains or developed authogenically by diagenesis or slight metamorphism. Also used more generally for finer grained material in any rock in which large components are set.

Detritus – A general term for fragmentary material, such as gravel, sand, clay, worn from rock by disintegration. Detrital grains in clastic sedimentary rocks may be composed of single mineral grains (e.g. monocrystalline quartz, plagioclase), polycrystalline mineral grains (e.g. polycrystalline quartz) or lithic fragments including sedimentary, igneous and metamorphic rock fragments.