PETROGRAPHIC REPORT ON FIVE DRILL CORE SAMPLES FROM THE PEENAM PROSPECT, AND A ROCK SAMPLE FROM THE GREAT BLACKALL MINE, GOOMERI DISTRICT, SOUTHEAST QUEENSLAND

For

Barlyne Mining

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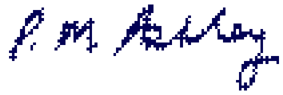

SUMMARY

Five drill core samples from the Peenam prospect and one rock sample from the Great Blackall mine, Goomeri district, southeast Queensland, were submitted for petrographic preparation, description and interpretation. The Peenam samples were from drill hole PEED01 at downhole intervals between 76.62 m and 262.94 m. Polished thin sections (PTS) were prepared from three of the Peenam samples and standard thin sections (TS) were prepared from the other three samples. PTS were subsequently examined microscopically in transmitted and reflected light, and TS in transmitted and oblique reflected light. Five section offcuts were treated with hydrofluoric acid and sodium cobaltinitrite in order to check for the presence of K-feldspar. Each sample was measured for magnetic susceptibility.

Summary descriptions of each sample are listed following:

Peenam

PEED01-1 141.75-141.85 m TS

Summary: Porphyritic microgranodiorite with a possible thin later intrusive dykelet of porphyritic microtonalite. Both rock types are texturally similar, having abundant plagioclase phenocrysts and less common phenocrysts of ferromagnesian phases (now altered, but could have included biotite and maybe hornblende and/or clinopyroxene). The fine to medium grained, inequigranular groundmasses of both rocks are also similar, but the microtonalite contains little or no K-feldspar accompanying plagioclase, quartz, biotite and FeTi oxide (titanomagnetite), whereas the microgranodiorite contains considerable K-feldspar. The latter rock type probably experienced mild potassic alteration, with minor replacement by K-feldspar, hydrothermal biotite, a little magnetite and trace chalcopyrite and pyrite. This alteration event was probably accompanied by emplacement of a few quartz-rich veins that also contain a little magnetite, K-feldspar, carbonate and chalcopyrite. It is possible that the microtonalite intruded the microgranodiorite after potassic alteration. Both rock types show pervasive propylitic alteration, more evident in the microgranodiorite. This type of alteration caused variable replacement of plagioclase by illite-sericite and carbonate, and ferromagnesian materials by chlorite and carbonate.

PEED01-2 262.86-262.94 m TS

Summary: Porphyritic alkali olivine basalt, showing moderate pervasive alteration that has resulted in all former olivine phenocrysts being replaced. The rock contains fresh relict phenocrysts of plagioclase and clinopyroxene, along with the pseudomorphs after olivine, in a fine to medium grained groundmass of smaller grains of plagioclase and clinopyroxene, granular FeTi oxide (titanomagnetite) and interstitial alkali feldspar, with a trace of biotite. It seems likely that there was local slight late magmatic replacement of olivine by biotite, but most olivine was replaced by pseudomorphic aggregates of nontronite. This phase has also commonly developed in the groundmass, along with trace carbonate. The rock contains a few amygdules containing opaline silica and/or quartz, and the sample exhibits a single thin carbonate vein.

PEED01-3 124.9-124.99 m PTS

Summary: Strongly hydrothermally altered and locally veined porphyritic microgranodiorite. The rock originally contained abundant plagioclase phenocrysts, and less common ferromagnesian phenocrysts (relict shapes of pseudomorphic aggregates suggest that they were biotite and hornblende) in a fine grained groundmass that contained K-feldspar, plagioclase and quartz, along with minor ferromagnesian grains and FeTi oxide (titanomagnetite). It is evident that the rock experienced moderate pervasive potassic alteration initially, indicated by variable replacement of ferromagnesian phenocrysts, groundmass and locally, plagioclase, by fine grained green to brown

biotite, along with a little magnetite, pyrite and chalcopyrite. This phase of alteration was accompanied by the emplacement of a few quartz-rich veins that also contain minor aggregates of magnetite and chalcopyrite. The rock subsequently experienced a moderate overprint by retrograde propylitic alteration, resulting in partial replacement of igneous minerals and hydrothermal biotite by illite-sericite and minor carbonate and chlorite.

PEED01-4 276.0-276.13 m PTS

Summary: Porphyritic microdiorite or basalt, with strong and pervasive "mafic potassic" alteration and minor veining. The rock contained abundant plagioclase phenocrysts, in a fine grained groundmass that has abundant ferromagnesian material and plagioclase. Alteration focussed on the groundmass, with replacement by fine grained biotite, plagioclase and disseminated magnetite, with minor anhydrite and a little quartz, pyrite and chalcopyrite. A few sub-planar veins cut the rock, with early types containing magnetite, biotite and local anhydrite, with trace pyrite and chalcopyrite. These are cut by a single later vein containing abundant quartz and minor carbonate, anhydrite, chlorite, chalcopyrite and magnetite. Minor chlorite retrogression of biotite is associated with this vein.

PEED01-5 76.62-76.72 m PTS

Summary: Porphyritic dacite or andesite with pervasive potassic alteration, quartz-rich veining and a subsequent retrograde overprint of propylitic alteration. The rock has moderately good retention of relict porphyritic texture and has relict plagioclase phenocrysts. Most original ferromagnesian phenocrysts (biotite, hornblende) were altered, although a little biotite remains. The rock has a fine grained recrystallised groundmass composed of plagioclase and minor K-feldspar, quartz and altered ferromagnesian material, plus disseminated FeTi oxide (titanomagnetite). Initial alteration resulted in significant replacement of hornblende and the groundmass by fine grained hydrothermal biotite, with a little magnetite and trace chalcopyrite. Veining might be related to potassic alteration, with sub-planar and locally intersecting veins containing abundant quartz and minor chalcopyrite, pyrite, magnetite, carbonate and chlorite. Retrograde propylitic alteration of the rock is manifest by replacement of igneous and earlier alteration minerals by carbonate, chlorite, sericite and trace hematite.

Great Blackall Mine

GrB01 TS

Summary: Medium to coarse grained, moderately porphyritic hornblende-quartz diorite. The rock contains scattered prismatic hornblende phenocrysts and a few plagioclase phenocrysts, intergrown with smaller grains of plagioclase, hornblende, a little interstitial quartz, biotite and FeTi oxide (titanomagnetite). Mild propylitic alteration was imposed, causing local alteration of the ferromagnesian minerals to chlorite, with trace epidote, and flecking of plagioclase by sericite and carbonate. Slight weathering effects led to nontronite development from biotite and chlorite, and to the rock being rather friable.

Interpretation and comment

Samples in the suite represent igneous rocks that have undergone hydrothermal alteration ranging from little (GrB01) to strong (several of the Peenam samples). There is also a range in primary compositions from mafic to felsic, and with each sample being variably porphyritic in texture. Veining and associated minor mineralisation are moderately significant in four of the Peenam samples.

Primary textures are generally well preserved in the Peenam samples, despite pervasive alteration, and there is some preservation of igneous minerals. The sample from Great Blackall mine (GrB01) is little altered and igneous minerals are well preserved. Four of the Peenam samples represent host rocks to an alteration-mineralisation system. Despite the alteration effects, the primary rock compositions in these samples can be estimated from the preserved and assumed primary mineralogy; they include porphyritic microgranodiorite (PEED01-1, PEED01-3), porphyritic microdiorite or basalt (PEED01-4) and porphyritic dacite or andesite (PEED01-5). A thin veinlike dyke of porphyritic microtonalite is recognised in PEED01-1. Each of these rock types contains relict phenocrysts of plagioclase, but most former ferromagnesian phenocrysts are altered and replaced by pseudomorphic aggregates. Only in PEED01-5 is a small amount of phenocrystal biotite preserved, but relict shapes after ferromagnesian grains suggest that biotite was formerly rather common, along with hornblende (and possibly, clinopyroxene). Microphenocrysts of FeTi oxide (titanomagnetite) are also locally preserved. The groundmass components are commonly fine grained but the variation in compositions distinguishes the samples, i.e. the relative proportions of plagioclase, K-feldspar, ferromagnesian material and quartz. Peenam sample PEED01-2 is a partly altered porphyritic alkali olivine basalt. It formerly contained scattered phenocrysts of olivine (now completely altered) and smaller phenocrysts of clinopyroxene and plagioclase, in a fine grained groundmass of the same minerals, a little alkali feldspar and FeTi oxide. This rock has not experienced the alteration-mineralisation effects shown in the other four Peenam samples and is consequently interpreted to be a later intrusive. Sample GrB01 is a porphyritic hornblende-quartz diorite, significantly coarser grained than the Peenam samples. It contains scattered phenocrysts of plagioclase and hornblende, intergrown with smaller grains of the same minerals, minor biotite, quartz and FeTi oxide.

It is possible that each sample, except PEED01-2, represents part of a suite of calc-alkaline, I-type intrusives, although whether there is any relationship between the samples, especially between those from Peenam and Great Blackall mine, remains completely speculative. As mentioned above, it is interpreted that porphyritic basalt sample PEED01-2 represents a later, unrelated intrusive.

The four Peenam samples showing significant alteration-mineralisation have pervasive potassic alteration characteristics superimposed on to the igneous mineralogy. This has particularly caused replacement of ferromagnesian phenocrysts by fine grained biotite and a little magnetite, with the groundmass component also being generally strongly affected. The latter has probable recrystallisation of feldspar ± quartz, as well as growth of biotite, a little magnetite, chalcopyrite and pyrite, and in the case of sample PEED01-4, development of a little anhydrite. Plagioclase phenocrysts are commonly little altered, although minor biotite has formed in places. This type of alteration is interpreted to have been accompanied by veining (albeit rather sparsely distributed) that include quartz-rich types (most samples) with a little associated chalcopyrite, magnetite, pyrite, carbonate (and anhydrite in PEED01-4) and biotite-magnetite (-anhydrite) (in PEED01-4). Each of these samples also shows weak through to stronger retrograde propylitic alteration that was superimposed later, causing further replacement of igneous minerals as well as potassic alteration minerals (e.g. biotite). Propylitic alteration is manifest by development of chlorite, carbonate and sericite.

Peenam sample PEED01-2 shows a different type of alteration, interpreted to be caused by a low-temperature diagenetic process, rather than hydrothermal. The dominant alteration in this sample is the replacement of olivine phenocrysts, and partial replacement of groundmass material, by goethite-impregnated nontronite clay. In places, there are traces of accompanying pyrite and amygdules in this rock contain infillings of opaline silica, quartz and nontronite. Great Blackall mine sample GrB01 has mild propylitic alteration imposed on the igneous minerals, with local replacement by chlorite, epidote, sericite and carbonate. This sample also has incipient weathering effects.

Minor vein-hosted and disseminated sulphides and magnetite have formed by hydrothermal processes in Peenam samples PEED01-1, PEED01-3, PEED01-4 and PEED01-5, and are interpreted to be related to the potassic alteration event. Disseminations of magnetite and sparse pyrite and chalcopyrite are part of the pervasive replacement assemblage. In the veins, magnetite occurs in both magnetite-rich types (e.g. in PEED01-4) as well as a component of the quartz-rich veins. Most chalcopyrite and pyrite occur in the quartz-rich veins. Total sulphide content of the rocks is estimated to achieve 2-3 volume %, with up to 1 volume % chalcopyrite in PEED01-3, PEED01-4 and PEED01-5. No particulate precious metal phase (e.g. gold, electrum) or molybdenite was observed in the samples.

The alteration-mineralisation characteristics observed in Peenam samples PEED01-1, PEED01-3, PEED01-4 and PEED01-5 are interpreted to be consistent with derivation from portion of a porphyry Cu system. The generally widely distributed veins and rather sparsely disseminated sulphides would suggest that the system, as sampled, is relatively “weak”. It is possible that none of the igneous rocks exhibited by these samples represents the intrusive mass (or masses) actually responsible for generating the system, rather that they represent part of the wall rock sequence. The reason for this is that much of the fine grained biotite in the rocks is pervasive and has the appearance of metamorphic biotite, although some is obviously vein-hosted. Similarly, none of the veins present shows strong alteration selvedge development, either of potassic, or, for example, retrograde phyllic type, that might be expected in well-developed porphyry style mineralisation.

Individual sample descriptions

PEED01-1 141.75-141.85 m TS

Summary: Porphyritic microgranodiorite with a possible thin later intrusive dykelet of porphyritic microtonalite. Both rock types are texturally similar, having abundant plagioclase phenocrysts and less common phenocrysts of ferromagnesian phases (now altered, but could have included biotite and maybe hornblende and/or clinopyroxene). The fine to medium grained, inequigranular groundmasses of both rocks are also similar, but the microtonalite contains little or no K-feldspar accompanying plagioclase, quartz, biotite and FeTi oxide (titanomagnetite), whereas the microgranodiorite contains considerable K-feldspar. The latter rock type probably experienced mild potassic alteration, with minor replacement by K-feldspar, hydrothermal biotite, a little magnetite and trace chalcopyrite and pyrite. This alteration event was probably accompanied by emplacement of a few quartz-rich veins that also contain a little magnetite, K-feldspar, carbonate and chalcopyrite. It is possible that the microtonalite intruded the microgranodiorite after potassic alteration. Both rock types show pervasive propylitic alteration, more evident in the microgranodiorite. This type of alteration caused variable replacement of plagioclase by sericite and carbonate, and ferromagnesian materials by chlorite and carbonate.

Handspecimen: The drill core sample displays two slightly different rock types, based on colour. A majority type is pinkish-grey and strongly porphyritic, with scattered white plagioclase phenocrysts and a few dark altered ferromagnesian phenocrysts up to 3 mm across. The other rock type is minor, with it being grey in colour, but texturally and mineralogically similar. It occurs as a possible narrow dyke-like body up to 1.5 cm wide. Both rock types have similar, fine grained quartzofeldspathic groundmasses. Staining of the section offcut with sodium cobaltinitrite showed that the pink-grey phase has significant K-feldspar in the groundmass, whereas the grey phase has little K-feldspar. Pervasive moderate alteration has occurred and it is likely that the pink-grey phase has experienced K-feldspar alteration, with deposition of a little disseminated magnetite and trace chalcopyrite and pyrite. There has also been chloritisation of ferromagnesian phases in both rock types. A couple of sub-planar quartz-rich veins occur, mostly hosted in the pink-grey phase. These veins are up to 3 mm wide, are at a moderate angle to the core axis, and contain traces of chalcopyrite. The sample must contain minor disseminated magnetite, as it is strongly magnetic, with susceptibility up to 3800 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that there are two compositionally different rock types present, both with good preservation of relict porphyritic texture. Both rock types are texturally similar. The majority phase (pink-grey in handspecimen) is strongly porphyritic, but considerably altered. It contains partly altered plagioclase phenocrysts up to 3 mm across and less common altered ferromagnesian phenocrysts up to 1 mm across (would have included biotite), in an inequigranular, fine to medium grained groundmass containing abundant turbid K-feldspar, plagioclase and quartz, with minor altered ferromagnesian material, disseminated FeTi oxide (titanomagnetite) and a trace of apatite. The minority phase in handspecimen (grey phase) is also strongly porphyritic, less altered and contains abundant zoned plagioclase phenocrysts up to 3 mm across and pseudomorphs after former ferromagnesian phenocrysts (e.g. biotite and possibly hornblende and/or clinopyroxene) up to 2 mm across in a fine to medium grained inequigranular groundmass dominated by plagioclase and quartz. There is also a little ferromagnesian material (including relict biotite), FeTi oxide and trace apatite. A little K-feldspar only occurs locally. The majority rock type is interpreted as a porphyritic microgranodiorite and the minority rock type is a porphyritic microtonalite. Since the latter is less altered, it is possible that it has intruded later.

b) Alteration and structure: Both rock types show pervasive hydrothermal alteration, but effects are mostly in the microgranodiorite. In the latter, it is interpreted that there was initial mild potassic alteration, resulting in local replacement of plagioclase by K-feldspar. It is also possible that some of the igneous ferromagnesian material was replaced by hydrothermal biotite, with traces of magnetite, chalcopyrite and pyrite. A few sub-planar quartz-rich veins up to 3 mm wide were emplaced, possibly related to the potassic alteration event. They are hosted in the microgranodiorite and contain abundant fine to medium grained, inequigranular quartz, with a little magnetite, K-feldspar, chalcopyrite and carbonate, with slight K-feldspar development along their margins. Subsequently, the microgranodiorite was retrogressively altered to form a propylitic assemblage. This probably occurred after emplacement of the microtonalite dykelet, which also has moderate propylitic alteration. In this type of alteration, there was partial replacement of plagioclase (less in the microtonalite) by sericite and carbonate, and replacement of most ferromagnesian material (including biotite) by chlorite ± quartz, carbonate and rutile. FeTi oxide (including magnetite) is slightly replaced by hematite.

c) Mineralisation: The sample contains a little relict igneous FeTi oxide (titanomagnetite) in both rock types, with grains up to 0.8 mm across. It is interpreted that a little hydrothermal magnetite and trace chalcopyrite and pyrite formed during the potassic alteration in the microgranodiorite (e.g. at altered ferromagnesian sites). A little magnetite and chalcopyrite (grains up to 0.4 mm across) also occur in the quartz-rich veins.

Mineral Mode (by volume): plagioclase 35%, K-feldspar and quartz each 20%, chlorite 10%, carbonate 6%, sericite 5%, FeTi oxide (including magnetite) 3% and traces of biotite, apatite, chalcopyrite, pyrite and rutile.

Interpretation and comment: It is interpreted that the sample contains two compositionally different igneous rock types. The dominant phase is a porphyritic microgranodiorite, exhibiting a possible thin later intrusive dykelet of porphyritic microtonalite. Both rock types are texturally similar, having abundant plagioclase phenocrysts and less common phenocrysts of ferromagnesian phases (could have included biotite and maybe hornblende and/or clinopyroxene). Groundmasses of both rocks are also similar, but the microtonalite contains little or no K-feldspar accompanying plagioclase, quartz, biotite and FeTi oxide (titanomagnetite), whereas the microgranodiorite contains considerable K-feldspar. The latter rock type probably experienced mild potassic alteration, with minor replacement by K-feldspar, hydrothermal biotite, a little magnetite and trace chalcopyrite and pyrite, and accompanied by emplacement of a few quartz-rich veins that also contain a little magnetite, K-feldspar, carbonate and chalcopyrite. It is possible that the microtonalite intruded the microgranodiorite after potassic alteration. Both rock types show pervasive propylitic alteration, more evident in the microgranodiorite. This type of alteration caused variable replacement of plagioclase by sericite and carbonate, and ferromagnesian materials by chlorite and carbonate.

<u>PEED01-2 262.86-262.94 m TS</u>

Summary: Porphyritic alkali olivine basalt, showing moderate pervasive alteration that has resulted in all former olivine phenocrysts being replaced. The rock contains fresh relict phenocrysts of plagioclase and clinopyroxene, along with the pseudomorphs after olivine, in a fine to medium grained groundmass of smaller grains of plagioclase and clinopyroxene, granular FeTi oxide (titanomagnetite) and interstitial alkali feldspar, with a trace of biotite. It seems likely that there was local slight late magmatic replacement of olivine by biotite, but most olivine was replaced by pseudomorphic aggregates of nontronite. This phase has also commonly developed in the groundmass, along with trace carbonate. The rock contains a few amygdules containing opaline silica and/or quartz, and the sample exhibits a single thin carbonate vein.

Handspecimen: The drill core sample is composed of a massive, porphyritic fine to medium grained mafic igneous rock. It contains scattered dark brown alteration aggregates up to several millimetres across that are pseudomorphous after a former blocky to prismatic ferromagnesian phenocryst phase (could have been olivine). The remainder of the rock is grey, with abundant laths of plagioclase and small dark grains of pyroxene. The rock is probably basaltic/doleritic in character, with the alteration aggregates possibly being composed of serpentine and/or clay minerals. The sample must contain minor disseminated magnetite, as it is strongly magnetic, with susceptibility up to 2040 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the sample is a moderately altered, porphyritic mafic igneous rock. There are scattered tabular phenocrysts of plagioclase (commonly zoned) up to 3 mm long, as well as subhedral phenocrysts up to 1.5 mm across (and small glomeroporphyritic groups) of pale pink-brown clinopyroxene (e.g. weakly titanian augite). The rock also contains scattered pseudomorphs up to 3.5 mm across after a former blocky to prismatic ferromagnesian phase, interpreted to have been olivine, judging by relict grain shape and the alteration assemblage. The phenocrysts occur in a fine to medium grained groundmass (typical grainsize <0.5 mm) with abundant small laths of plagioclase, subordinate clinopyroxene, granular FeTi oxide (e.g. titanomagnetite), minor interstitial alkali feldspar and a trace of biotite. A single xenocryst of quartz, perhaps originally up to 1 few millimetres across, displays a reaction rim of stubby clinopyroxene grains and showing subsequent strong replacement of remnant quartz by fine grained decussate and sub-radiating aggregates of pale brown amphibole (maybe tremolitic). From the textural and mineralogical characteristics, it is interpreted that the sample represents an altered porphyritic alkali olivine basalt.

b) Alteration and structure: Moderate pervasive alteration has occurred, mostly due to deuteric processes, but possibly also including earlier late-magmatic/post-magmatic alteration. At former olivine phenocryst sites, there was possible early local replacement of olivine by biotite. The replacement of xenocrystal quartz by clinopyroxene and amphibole could also reflect an early alteration process. However, most alteration has occurred at low temperature and is manifest by replacement of remaining olivine by pseudomorphic aggregates dominated by orange-brown, goethite-impregnated nontronite, together with a little green-brown nontronite and trace pyrite. Minor patchy development of green-brown nontronite has occurred throughout the groundmass, along with a trace of carbonate and pyrite. The rock contains a few irregular amygdules up to 4 mm across that are filled by isotropic opaline silica and/or sub-radiating quartz masses and a little nontronite. The rock is cut by a single, somewhat sinuous, carbonate vein up to 0.2 mm across.

c) Mineralisation: The rock retains considerable fine grained igneous FeTi oxide (e.g. titanomagnetite), with largest grains up to 0.2 mm across (these are mostly found at altered olivine sites). During alteration, a little pyrite, forming aggregates up to 0.3 mm across, developed at former olivine sites and in the groundmass.

Mineral Mode (by volume): plagioclase 50%, nontronite 20%, clinopyroxene 17%, alkali feldspar 5%, FeTi oxide 4%, opaline silica + quartz 2%, amphibole and carbonate each 1% and traces of biotite and pyrite.

Interpretation and comment: It is interpreted that the sample represents a moderately altered porphyritic alkali olivine basalt. It contains phenocrysts of plagioclase and clinopyroxene, with scattered pseudomorphs after olivine, in a fine to medium grained groundmass of smaller grains of plagioclase and clinopyroxene, granular FeTi oxide (titanomagnetite) and interstitial alkali feldspar, with a trace of biotite. There was possible early replacement of olivine by biotite, and xenocrystic quartz by clinopyroxene and amphibole, but most olivine was later replaced by pseudomorphic aggregates of nontronite. This phase has also commonly developed in the groundmass, along with trace carbonate. The rock contains a few amygdules containing opaline silica and/or quartz, and the sample exhibits a single thin carbonate vein.

PEED01-3 124.9-124.99 m PTS

Summary: Strongly hydrothermally altered and locally veined porphyritic microgranodiorite. The rock originally contained abundant plagioclase phenocrysts, and less common ferromagnesian phenocrysts (relict shapes of pseudomorphic aggregates suggest that they were biotite and hornblende) in a fine grained groundmass that contained K-feldspar, plagioclase and quartz, along with minor ferromagnesian grains and FeTi oxide (titanomagnetite). It is evident that the rock experienced moderate pervasive potassic alteration initially, indicated by variable replacement of ferromagnesian phenocrysts, groundmass and locally, plagioclase, by fine grained green to brown biotite, along with a little magnetite, pyrite and chalcopyrite. This phase of alteration was accompanied by the emplacement of a few quartz-rich veins that also contain minor aggregates of magnetite and chalcopyrite. The rock subsequently experienced a moderate overprint by retrograde propylitic alteration, resulting in partial replacement of igneous minerals and hydrothermal biotite by sericite and minor carbonate and chlorite.

Handspecimen: The drill core sample is composed of a massive, pale brownish-grey, altered porphyritic fine grained intermediate to felsic igneous rock. Relict strongly porphyritic texture is moderately well preserved and it is evident that there are plagioclase and altered ferromagnesian phenocrysts up to a few millimetres across in a fine grained quartzofeldspathic groundmass. Staining of the section offcut with sodium cobaltinitrite showed that there is considerable K-feldspar in the groundmass. It is likely that minor fine grained hydrothermal biotite formed as a pervasive alteration product, along with minor chlorite and sericite, and trace disseminated magnetite, pyrite and chalcopyrite. The altered rock is cut by a few sub-planar grey quartz-rich veins up to 4 mm wide at a moderate angle to the core axis. A little chalcopyrite and magnetite are evident in the quartz-rich veins. Due to the presence of magnetite, the sample is strongly magnetic, with susceptibility up to 4780 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, the rock has a moderately well preserved strongly porphyritic texture. There are abundant tabular, commonly zoned, plagioclase phenocrysts, and less common altered ferromagnesian phenocrysts, each up to 2 mm across. Relict shapes of the latter suggest that biotite and hornblende would have been present. The phenocrystal phases were set in a fine grained, rather granular groundmass containing abundant K-feldspar, subordinate plagioclase and quartz, altered ferromagnesian material, disseminated FeTi oxide (e.g. titanomagnetite) and traces of zircon and apatite. The bulk mineralogical composition and texture of the sample indicates that it represents an altered porphyritic microgranodiorite.

b) Alteration and structure: Strong pervasive alteration was imposed and several veins emplaced. It is interpreted that there was initial potassic alteration, indicated by patchy replacement of ferromagnesian phases, groundmass and to a small extent, plagioclase phenocrysts, by fine grained aggregates of green to brown hydrothermal biotite, commonly accompanied by a little magnetite, pyrite and chalcopyrite. Elsewhere, the latter three minerals also formed sparsely (e.g. in the groundmass) in the absence of associated biotite. It is likely that this alteration event was accompanied by emplacement of a few sub-planar quartz-rich veins up to 4 mm wide. The veins are dominated by fine to medium grained, inequigranular quartz, but commonly with scattered aggregates of magnetite and chalcopyrite, and a little carbonate and chlorite. Subsequently, the rock experienced a moderate retrograde alteration overprint of propylitic type, causing variable replacement of ferromagnesian phases (including hydrothermal biotite) and feldspars by sericite, minor carbonate and chlorite, and a trace of rutile.

c) Mineralisation: Possible minor relict igneous FeTi oxide (titanomagnetite) occurs in the sample. It is interpreted that minor disseminated magnetite and pyrite aggregates (up to 0.6 mm across), together with a little chalcopyrite, formed in the host rock as a result of potassic alteration. The quartz-rich veins also contain scattered aggregates of magnetite (up to 2 mm across) and less common chalcopyrite (up to 1 mm across), with several composite aggregates involving both minerals.

Mineral Mode (by volume): plagioclase 30%, K-feldspar and quartz each 20%, sericite 12%, biotite 8%, FeTi oxide (includes magnetite) 3%, chlorite, carbonate and pyrite each 2%, chalcopyrite 1% and traces of rutile, zircon and apatite.

Interpretation and comment: It is interpreted that the sample is a porphyritic microgranodiorite that has experienced pervasive hydrothermal alteration and local veining. It originally contained abundant plagioclase phenocrysts, and less common ferromagnesian phenocrysts (maybe biotite and hornblende) in a fine grained groundmass that contained K-feldspar, plagioclase and quartz, minor ferromagnesian grains and FeTi oxide (titanomagnetite). The sample experienced moderate initial potassic alteration, manifest by variable replacement of ferromagnesian phenocrysts, groundmass and locally, plagioclase, by fine grained green to brown biotite, along with a little magnetite, pyrite and chalcopyrite. This phase of alteration occurred with emplacement of a few quartz-rich veins with minor magnetite and chalcopyrite. There was later moderate retrograde propylitic alteration, resulting in partial replacement of igneous minerals and hydrothermal biotite by sericite and minor carbonate and chlorite.

PEED01-4 276.0-276.13 m PTS

Summary: Porphyritic microdiorite or basalt, with strong and pervasive "mafic potassic" alteration and minor veining. The rock contained abundant plagioclase phenocrysts, in a fine grained groundmass that has abundant ferromagnesian material and plagioclase. Alteration focussed on the groundmass, with replacement by fine grained biotite, plagioclase and disseminated magnetite, with minor anhydrite and a little quartz, pyrite and chalcopyrite. A few sub-planar veins cut the rock, with early types containing magnetite, biotite and local anhydrite, with trace pyrite and chalcopyrite. These are cut by a single later vein containing abundant quartz and minor carbonate, anhydrite, chlorite, chalcopyrite and magnetite. Minor chlorite retrogression of biotite is associated with this vein.

Handspecimen: The drill core sample is composed of a relatively massive, dark brownish-grey, altered porphyritic fine grained intermediate to mafic igneous rock. It has a few feldspar phenocrysts up to 2 mm across in a fine grained groundmass that is probably rather feldspathic, but shows development of fine grained biotite. A few sub-planar veins cut the altered rock at low angles to the core axis and are up to 2 mm wide. These veins locally intersect and show assemblages ranging from quartz-rich (with a little chalcopyrite and pyrite) to dark biotite- and magnetite-rich types. Staining of the section offcut with sodium cobaltinitrite showed that there is minor K-feldspar in the groundmass. The rock must contain minor magnetite, as the sample is strongly magnetic, with susceptibility up to 8700 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately well preserved. The rock has abundant tabular zoned plagioclase phenocrysts up to 2 mm across (although most are <1 mm) in a completely altered and recrystallised fine grained groundmass that probably contained rather abundant ferromagnesian material and plagioclase, plus disseminated FeTi oxide. Relict plagioclase is fairly calcic in composition (andesine-labradorite) suggesting that the original rock was of mafic to intermediate composition, e.g. porphyritic basalt or microdiorite. A single enclave about 6 mm across is enclosed. It is of similar igneous composition, but texturally different with a more crowded phenocryst texture.

b) Alteration and structure: The original igneous rock was strongly altered, causing extensive replacement and recrystallisation, mostly of groundmass material, as well as being veined. The groundmass was replaced by varying amounts of fine grained biotite, minor recrystallised plagioclase, irregularly distributed magnetite, a little K-feldspar, anhydrite, quartz and traces of carbonate, pyrite and chalcopyrite. Magnetite commonly forms small aggregates, enclosed by biotite aggregates. Plagioclase is locally slightly replaced by biotite, but mostly lightly flecked by sericite and carbonate. The alteration assemblage is considered to be of "mafic potassic" type. The rock is cut by several sub-planar veins, with some being discontinuous. There may be two generations of veining, with early veins up to 0.5 mm wide that contain varying amounts of magnetite, biotite and local anhydrite, plus trace pyrite and chalcopyrite. This type is cut by a single sub-planar vein up to 0.6 mm wide of fine to medium grained quartz, with minor carbonate, anhydrite, chalcopyrite, magnetite and chlorite. About this vein, minor chlorite has formed as a thin retrograde selvedge and elsewhere in the rock, biotite shows slight patchy replacement by chlorite.

c) Mineralisation: The sample contains minor vein-hosted and disseminated magnetite, as part of the potassic alteration assemblage. Early veins also contain traces of pyrite and chalcopyrite, and these phases also occur as trace constituents in the altered rock. The later quartz-rich vein contains minor chalcopyrite and magnetite, with chalcopyrite masses up to 0.5 mm across.

Mineral Mode (by volume): plagioclase 60%, biotite 20%, magnetite and K-feldspar each 5%, anhydrite 3%, quartz, chlorite and sericite each 2%, chalcopyrite 1% and traces of carbonate and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly potassically altered porphyritic intermediate to mafic igneous rock, perhaps originally a basalt or microdiorite. It contained abundant plagioclase phenocrysts, in a fine grained groundmass that has abundant ferromagnesian material and plagioclase. Potassic alteration mainly affected the groundmass, with replacement by fine grained biotite, plagioclase and disseminated magnetite, with minor anhydrite and a little quartz, pyrite and chalcopyrite. A few sub-planar veins cut the rock, with early types containing magnetite, biotite and local anhydrite, with trace pyrite and chalcopyrite. These are cut by a single later vein with abundant quartz and minor carbonate, anhydrite, chlorite, chalcopyrite and magnetite. Minor chlorite retrogression of biotite is associated with this vein.

PEED01-5 76.62-76.72 m PTS

Summary: Porphyritic dacite or andesite with pervasive potassic alteration, quartz-rich veining and a subsequent retrograde overprint of propylitic alteration. The rock has moderately good retention of relict porphyritic texture and has relict plagioclase phenocrysts. Most original ferromagnesian phenocrysts (biotite, hornblende) were altered, although a little biotite remains. The rock has a fine grained recrystallised groundmass composed of plagioclase and minor K-feldspar, quartz and altered ferromagnesian material, plus disseminated FeTi oxide (titanomagnetite). Initial alteration resulted in significant replacement of hornblende and the groundmass by fine grained hydrothermal biotite, with a little magnetite and trace chalcopyrite. Veining might be related to potassic alteration, with sub-planar and locally intersecting veins containing abundant quartz and minor chalcopyrite, pyrite, magnetite, carbonate and chlorite. Retrograde propylitic alteration of the rock is manifest by replacement of igneous and earlier alteration minerals by carbonate, chlorite, sericite and trace hematite.

Handspecimen: The drill core sample is composed of a relatively massive, altered porphyritic intermediate igneous rock. It displays scattered plagioclase phenocrysts up to 2 mm across in a dark brownish-grey fine grained altered groundmass that although rather feldspathic, also contains significant biotite. Staining of the section offcut with sodium cobaltinitrite showed that there is minor K-feldspar in the groundmass. The rock is cut by a few sub-planar quartz-rich veins up to 4 mm wide, at varying angles to the core axis and locally intersecting. In the veins, there are small amounts of chalcopyrite, pyrite and magnetite. Due to the presence of magnetite, the sample is strongly magnetic, with susceptibility up to 2130 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately well preserved. The rock has significant retention of tabular zoned plagioclase phenocrysts up to 2 mm across. Ferromagnesian phenocrysts were up to 1.5 mm across, but are now mostly altered, with only a little biotite remaining. Relict shapes of the pseudomorphic aggregates suggest that in addition to biotite, hornblende was also originally present. The rock also contained a few microphenocrysts of FeTi oxide (titanomagnetite). Phenocrystal phases were set in a fine grained groundmass that although now altered and recrystallised, can be implied to have contained abundant plagioclase, with lesser amounts of K-feldspar, quartz, ferromagnesian material, a little FeTi oxide and trace zircon and apatite. From the relict characteristics, the primary rock is interpreted as a porphyritic dacite or andesite.

b) Alteration and structure: Strong pervasive hydrothermal alteration was imposed and several veins emplaced. Original hornblende was replaced by fine grained hydrothermal biotite aggregates, plus trace magnetite. Biotite and minor magnetite, plus trace chalcopyrite also developed by groundmass replacement, with the remainder of the groundmass probably being finely recrystallised and with local development of small quartz aggregates. The alteration characteristics are consistent with potassic type. The veins were possibly emplaced during or after the potassic alteration. They are up to 3.5 mm wide, are generally sub-planar, and locally intersect. Fine to medium grained, inequigranular quartz dominates, with minor chalcopyrite, pyrite, magnetite, carbonate and chlorite. The rock later sustained retrograde alteration of propylitic type, causing partial replacement of ferromagnesian material, including hydrothermal biotite by chlorite and trace rutile, development of considerable carbonate and lesser sericite in the groundmass and from plagioclase, and local replacement of magnetite by hematite.

c) Mineralisation: A little magnetite and trace chalcopyrite occurs as part of the pervasive alteration. Magnetite forms aggregates up to 0.4 mm across and some could represent original igneous material. In the veins, there is minor chalcopyrite (aggregates to 1.5 mm), pyrite (to 2 mm) and magnetite (to 0.5 mm). Chalcopyrite and magnetite locally form composites and paragenetically, chalcopyrite post-dates pyrite and magnetite. A little hematite has formed from magnetite.

Mineral Mode (by volume): plagioclase 50%, quartz 15%, biotite and carbonate each 8%, chlorite 6%, K-feldspar 5%, FeTi oxide (includes magnetite) 3%, sericite 2%, pyrite and chalcopyrite each 1% and traces of rutile, zircon, apatite and hematite.

Interpretation and comment: It is interpreted that the sample is an altered and locally veined porphyritic dacite or andesite. Relict porphyritic texture is rather well preserved and there are relict plagioclase phenocrysts. Most original ferromagnesian phenocrysts (biotite, hornblende) were altered, although a little biotite remains. The rock has a fine grained recrystallised groundmass composed of plagioclase and minor K-feldspar, quartz and altered ferromagnesian material, plus disseminated FeTi oxide (titanomagnetite). Initial alteration was or potassic type, causing significant replacement of hornblende and the groundmass by fine grained hydrothermal biotite, with a little magnetite and trace chalcopyrite. Veining might be related to potassic alteration, with sub-planar and locally intersecting veins containing abundant quartz and minor chalcopyrite, pyrite, magnetite, carbonate and chlorite. Retrograde propylitic alteration of the rock is manifest by replacement of igneous and earlier alteration minerals by carbonate, chlorite, sericite and trace hematite.

GrB01 TS

Summary: Medium to coarse grained, moderately porphyritic hornblende-quartz diorite. The rock contains scattered prismatic hornblende phenocrysts and a few plagioclase phenocrysts, intergrown with smaller grains of plagioclase, hornblende, a little interstitial quartz, biotite and FeTi oxide (titanomagnetite). Mild propylitic alteration was imposed, causing local alteration of the ferromagnesian minerals to chlorite, with trace epidote, and flecking of plagioclase by sericite and carbonate. Slight weathering effects led to nontronite development from biotite and chlorite, and to the rock being rather friable.

Handspecimen: The sample is composed of a massive, slightly porphyritic, medium to coarse grained intermediate igneous rock, e.g. diorite. It contains abundant pale grey plagioclase and dark greenish prismatic hornblende, with grainsize up to several millimetres. Testing of the section offcut with sodium cobaltinitrite did not reveal the presence of K-feldspar. The rock appears slightly weathered and is rather friable. Minor disseminated magnetite must occur, as the rock is strongly magnetic, with susceptibility up to 3740 x 10^{-5} SI units.

Petrographic description

a) Primary rock characteristics: In the section, the rock is relatively fresh and there is good preservation of igneous minerals and texture. The rock is moderately porphyritic, with a few blocky, zoned plagioclase phenocrysts up to 3 mm across and prismatic green hornblende phenocrysts up to 6 mm long. These are intergrown with smaller grains of interlocking plagioclase and hornblende, and with minor interstitial quartz (up to 1 mm), a few grains of biotite, disseminated FeTi oxide (titanomagnetite) up to 0.6 mm across and a few grains of apatite. Biotite is locally intergrown with hornblende and could have replaced the latter. From the mineralogical and textural characteristics, the rock is interpreted as a porphyritic hornblende-quartz diorite.

b) Alteration and structure: Mild alteration pervades the rock and there is also evidence of slight effects of imposed weathering. Most biotite is partly altered to chlorite and hornblende shows rare replacement by chlorite and epidote. Plagioclase is locally flecked by fine grained sericite and carbonate. The supergene effects are manifest by development of orange-.brown nontronite from biotite and chlorite. The alteration is interpreted to be of propylitic type. No veining is observed.

c) Mineralisation: The sample retains scattered grains of igneous FeTi oxide (titanomagnetite) up to 0.6 mm across. No sulphide minerals are observed.

Mineral Mode (by volume): plagioclase 60%, hornblende 27%, quartz 5%, FeTi oxide 3%, biotite/nontronite and sericite each 2%, carbonate 1% and traces of epidote and apatite.

Interpretation and comment: It is interpreted that the sample represents a hornblende-quartz diorite. It is medium to coarse grained and moderately porphyritic and is clearly of I-type affinity. It contains scattered prismatic hornblende phenocrysts and a few plagioclase phenocrysts, intergrown with smaller grains of plagioclase, hornblende, a little interstitial quartz, biotite and FeTi oxide (titanomagnetite). Mild propylitic alteration occurred, with local alteration of the ferromagnesian minerals to chlorite and trace epidote, and flecking of plagioclase by sericite and carbonate. Slight weathering effects led to nontronite development from biotite and chlorite, and to the rock being rather friable.