SAMPLE: 562691 80-45m

SUMMARY: This sample is a strongly carbonate-chlorite-altered augite+ plagioclase-phyric basaltic pumice breccia.

HAND SPECIMEN:

This is a dark green basaltic lava breccia with fragments varying from highly vesicular to massive, up to several cm long.

THIN SECTION DESCRIPTION:

This sample is composed of numerous rather large fragments of augite+plagioclase-phyric basaltic lava that vary from almost massive to almost totally vesiculated. The rock is intensely calcite-chlorite-altered, and the original texture of many fragments is obliterated. Former augite phenocrysts are replaced by calcite and minor chlorite, and reach almost 3mm long, although their original modal abundance is difficult to estimate. Plagioclase phenocrysts were about equally as abundant, but are much smaller (mainly <1mm long) and albitized; most are totally sericitized. Most of the highly vesicular fragments were clearly pumiceous, but are now composed of calcite, chlorite in the vesicles, and rims of Fe oxide or hydroxide often rim the chlorite-filled vesicles. Thin meandering quartz veinlets are overprinted by calcite, but several generations of carbonate alteration are probably present.

This sample was a highly vesicular and glassy augite+plagioclase-phyric basaltic lava breccia or pumice breccia. An identical unit was noted in Placer hole BRD-05 near the top of the Hellyer basalt. The extensive alteration is likely due to the originally highly glassy and porous nature of the pumice breccia.

SAMPLE: 562692 85-3m

SUMMARY: This rock is a weakly autobrecciated formerly glassy and sparsely plagioclase-phyric dacite lava that has suffered quite strong silica alteration, and subsequent weak sericitization.

THIN SECTION DESCRIPTION:

This sample was probably a weakly autobrecciated dacitic lava composed of around 3-5 modal% of altered feldspar phenocrysts in a formerly glassy groundmass that has been strongly recrystallized and probably silicified. The former plagioclase phenocrysts are 0.5-2mm long and strongly sericite-altered blocky prisms with probably near-euhedral shapes originally; however, recrystallization of glassy groundmass has involved reactions with margins of phenocrysts, which are rather ragged in many cases. Former FeTi oxide microphenocrysts were present but not very common, and have altered to leucoxenitic material. One or two very small chlorite-filled crystal sites may have been small augite phenocrysts.

The groundmass of this sample was originally glassy to extremely finely vitrophyric. However, in most areas of the slide, devitrification quartz-albite mosaic textures have been obliterated by recrystallization to granular quartz-dominated regions with minor interstitial pale green chlorite, and even less-abundant calcite spotting. In some areas the fine-grained sugary silica increases in grainsize in irregular patches cored by larger concentrations of chlorite . Quartz also forms small veinlets that transect the rock. Intense sericite alteration occurs in zones that cut across the rock, and appear to post-date the silicification, although fine-grained sericite is abundant throughout the rock, except in those areas of strongest and most-coarse-grained silica alteration.

SAMPLE: 562693 112.4m

SUMMARY: This sample is a microvesicular formerly plagioclase+augite - phyric basalt or basaltic andesite lava.

HAND SPECIMEN:

This is a massive dark grey-brown mafic or intermediate lava with calcite spots to several mm across and small phenocrysts of feldspar and a mafic phase.

THIN SECTION DESCRIPTION:

This sample was a microvesicular plagioclase+augite-phyric basalt or basaltic andesite that has suffered quite strong calcite alteration. Former augite phenocrysts to about 1.5mm across make up about 3-5 modal% of the rock and are totally replaced by dirty brown calcite with intergrown green chlorite. Plagioclase phenocrysts are notably more abundant than augite and range from 0.1-2mm long; they are albitized, and many are slightly rounded and resorbed-looking. They commonly occur in multi-crystal clots, or intergrown with augite in small cognate gabbroic inclusions. Small epidote granules commonly occur in albite crystals, although sericite is uncommon. Small leucoxenitized FeTi oxide microphenocrysts are reasonably abundant. A reasonable man may well ask just what is reasonable when it comes to FeTi oxide abundances.

The groundmass of this sample was vitrophyric and riddled with tiny gas bubbles and trails. The former glass, now devitrified to a dark irresolvable material, is charged with tiny microlites of albite, and full of blebs of quartz and chlorite, with occasional intergrown epidote. Calcite occurs as brownish patches overprinting groundmass, and as angular patches and veinlets.

This is a plagioclase+augite-phyric evolved basaltic lava, probably approaching an andesite composition.

SAMPLE: 562694 132.4m

SUMMARY: This sample is a strongly carbonate-chlorite-altered polymict basaltic lava breccia.

HAND SPECIMEN:

This is a heterogeneous, rather coarse, strongly carbonate altered lava breccia including massive, finely porphyritic, to highly vesicular and chloritized lava fragments in a very heterogeneous, altered matrix.

THIN SECTION DESCRIPTION:

This sample is seen in thin section to be a basaltic lava breccia composed of two distinct domains corresponding to different lava fragments. The better preserved lava is strongly vesicular, but with very small (<<0.5mm across) vesicles that are filled with secondary quartz and calcite. It contains around 10 modal% of very large (to 4mm long) and complexly intergrown fresh augite phenocrysts, and considerably less but noticeable amounts of totally altered small olivine phenocrysts, now replaced by finely granular quartz and chlorite, with minor calcite. The groundmass of this fragment was glassy and very finely vesicular, and has devitrified and altered to an isotropic irresolvable material shot through with tiny blebs of quartz and quartz-lined, chlorite-filled cavities. The other lava fragment(s) was far more coarsely vesicular, and evolved than the fragment described above. It consists of around 10 modal% of large fresh augite phenocrysts, but unlike the other fragment, also contains quite common smaller (<1mm long) albitized plagioclase phenocrysts. The highly vesicular (almost pumiceous) glassy groundmass has been extensively replaced by matted green chlorite and abundant calcite, with common stringers of epidote and secondary quartz.

This sample was clearly a polymict basaltic lava breccia in which the more glassy and vesicular fragments were more intensely carbonate-chlorite-altered.

SAMPLE: 562695 149·85m

SUMMARY: This sample is either a lithic tuff, or a felsic lapilli volcaniclastic derived from mass flow that involved minimum reworking.

HAND SPECIMEN:

This is a dark green polymict andesitic volcaniclastic or lithic tuff, with fragments up to around 1cm long; it is interbedded with a finer-grained tuff or shale in which lava fragments also occur.

THIN SECTION DESCRIPTION:

This rock is clearly polymict, with fragments varying widely in their texture and abundance of phenocrysts. Most fragments were probably fairly glassy quite strongly plagioclase-phyric andesite to dacite, dominated by blocky to tabular albite phenocrysts rarely longer than 1.5mm. Few, if any, former mafic phenocrysts were originally present in the lava fragments that make up this sample. The main petrographic difference between fragments is the original degree of crystallinity of the groundmass, and the degree to which the devitrified groundmasses have been altered. A few fragments are devitrified rhyolitic glass, variably vesicular (vesicles are quartz-filled), but not attaining enough vesicularity to be termed pumice.

The matrix of this rock is very difficult to discern from the fragments, and was probably very largely composed of glassy ash, tiny angular fragments of largely glassy felsic lava and angular albite crystal fragments. The degree of devitrification and superimposed alteration precludes preservation of glass shards. Devitrification produced variably-textured quartz-albite± minor chlorite mosaics from glassy groundmasses, and quite strong sericite-carbonate alteration has overprinted devitrification textures. The sericite alteration defines a very weak fabric that crosscuts the entire rock, but is better developed in some fragments than others, probably reflecting original 'glassiness'. Some degree of silicification has also affected this sample, and is best evidenced by irregular seams and patches of groundmass that are much 'clearer' and 'cleaner' than the remainder of the rock. Broadly, these parallel the weak foliation and may have developed at the same time.

This sample was probably a lithic tuff deposited from some hot mass flow without significant .reworking. It cannot be precluded, however, that it is a slump-type mass flow derived from the side of a felsic volcanic edifice, and in this case would best be classified as a felsic lapilli volcaniclastic.

SAMPLE: 562696 159·45m

SUMMARY: This sample is an andesitic to dacitic lithic tuff dominated by fragments of strongly plagioclase-phyric lava. It has suffered variable but generally quite strong calcite-sericite alteration.

HAND SPECIMEN:

This is a dark green volcaniclastic sandstone with diverse clasts ranging up to around 1cm long.

THIN SECTION DESCRIPTION:

This sample in thin section is seen to be probably more akin to a lithic tuff than a sandstone. It is composed dominantly of abundantly (15-18 modal%) plagioclase- phyric andesitic to dacitic lava clasts with fine-grained but not highly glassy groundmasses charged with tiny albite microlites. These fragments/clasts are probably derived from a single flow/eruption, with textural differences in the groundmass simply reflecting cooling or quenching history differences. Rather more fine-grained or formerly glassy lava fragments are also present, and are not as common, or as phenocryst-rich as the main lava fragments. One quite large sparsely plagioclase -phyric dacitic lava fragment with a sericitized glassy groundmass is distinctive. Many albitized plagioclase phenocrysts are broken and are probably sitting in formerly glassy ash that has variably devitrified and been overprinted by the extensive calcite-sericite alteration that typifies this sample.

This rock was probably a lithic tuff of andesitic to dacitic affinities. I think it has not suffered any reworking, and is therefore unlikely to be a volcaniclastic sediment. However, when a lapilli sandstone dominated by glassy lava fragments and a juvenile, glassy matrix devitrifies, it becomes exceedingly difficult to judge whether the primary texture implies reworking or not. The geological implications of choosing one or the other alteranative are not terribly significant, I suppose.

SAMPLE: 562697 274-1m

SUMMARY: This sample was a glassy felsic crystal lithic tuff that has suffered some brecciation and silicification.

HAND SPECIMEN:

This is a grey-green plagioclase-phyric massive dacitic lava with a rather heterogeneous groundmass, possibly partially silicified.

THIN SECTION DESCRIPTION:

This is a difficult sample to diagnose with confidence. It is clearly a felsic, plagioclase-phyric volcanic rock, although whether it is a crystal tuff, a massive 'false-brecciated' lava, or a genuine lava breccia, is difficult to ascertain. The only important mineral phase in the rock is albitized plagioclase. This occurs as well-formed phenocrysts to at least 2mm long, but also is present in abundance as angular crystal fragments and rounded and reacted crystals, suggesting some heterogeneity in the origin of these feldspars. Many albitized feldspars are riddled with yellow epidote crystals. No definite former mafic phenocrysts were noted.

The groundmass of this sample is quite heterogeneous texturally. A few areas that were probably definite fragments of altered glassy felsic lava are present. However, In its least-altered areas, the matrix of this rock is clearly formerly glassy, and well-developed former perlitic cracks are evident in several 'fragments'. In some places, this groundmass seems to have devitrified to isotropic irresolvable material, but in other areas, blebby fine-grained quartz has crystallized from the devitrified glass. Dark 'fragments' of least-altered rock are surrounded by angular and anastomosing regions of paler-coloured, quartz-rich material, slightly more coarse-grained than the devitrified glass; these areas are though to be due to soaking by silica-rich solutions during alteration. The rock is cut by veinlets of quartz, quartz-albite, quartz-chlorite, and rare calcite. This sample was probably a glass-rich crystal lithic tuff in which the uncommon lithic fragments were also glassy felsic lava.

SAMPLE: 562698 309·5m

SUMMARY: This rock was a basaltic to basaltic andesite hyaloclastite composed of mainly vesicular fragments spalled of a gas-rich flow. Subsequent strong silica-alteration filled vesicles and inter-fragment spaces.

HAND SPECIMEN:

This rock is appears to be a feldspar-phyric andesite, although close examination suggests that there are some small (<2mm across) formerly glassy lithic fragments.

THIN SECTION DESCRIPTION:

This is an exceptionally difficult sample to diagnose, due to the very unusual texture of the rock. It was originally probably a basaltic andesite compositionally, and consists essentially of abundant augite and altered plagioclase phenocrysts in a rather bizarre groundmass that probably was originally quite glassy. I suggest that the sample was a hyaloclastite composed of quite small (mainly << a few mm long) fragments of vesicular porphyritic lava with a quenched groundmass. These consist of about subequal amounts of blocky and tabular phenocrysts of sericite+prehnite-altered albite after calcic plagioclase, and mainly euhedral augite phenocrysts less than 1mm long; the augite is fresh and often occurs in multi-crystal clots. Three or four small crystal shapes now composed of pale green chlorite may have been former olivine phenocrysts, although in all cases, the shapes are not diagnostic.

The groundmass of this sample is strikingly unusual, and the interpretation offered is a best guess, rather than a positive identification. The texture of the groundmass shows several major domains that are quite different and probably correspond to different events in the formation of the sample.. The first of these, notably the clear fragmental texture, may confidently be assigned to a primary origin, since some fragments are non-vesicular, whereas others are highly vesicular (although of the same 'parent' lava). These fragments are rather angular, dark coloured and charged with flow-orientated tiny plagioclase microlites in devitrified glass. Within and between the darker coloured fragments are areas of lighter-coloured material, probably cryptocrystalline silica. This fills elongate and flattened vesicles in the dark lava

fragment domains, and fills most interstitial areas between fragments. Jigsaw-fit fragments are often separated by narrow projections and channels of the light very fine-grained silica. A most deceptive and important feature of this rock is the strange mix of euhedral augite crystals (within dark fragments) and remarkably angular, 'broken-looking' augite crystals (in lighter-coloured matrix). This initially led me to think that there was a major pyroclastic component in this sample. However, it is clear (upon the 345th look) that the angular fragments are relics of former euhedral crystals that have reacted and been eaten away by the silica-rich solutions from which formed the interstitial matrix cryptocrystalline silica. A third unusual feature of this sample is small areas (mainly 0.5-2mm across) of intense sericite alteration of the normally dark groundmass of many lava frgments. These are 'invisible' in plane polarized light, but show up remarkably strongly in crossed polars mode; they are well-defined, clearly not former feldspar phenocrysts or vesicle-fillings, and occasionally spherical (circular in section). These are very unevenly distributed throughout the rock, and are appear to post-date the silica alteration.

I suggest that this rock was a fine-grained basaltic or basaltic andesite hyaloclastite composed of fragments spalled from the gas-charged top of a single flow. Hot very silica-rich solutions permeated the rock, filling vesicles, pore spaces, and inter-fragments cavities with cryptocrystalline silica, and digesting augite crystals in the 'matrix' of the hyaloclastite. Subsequent sericite-alteration developed in irregular areas, probably controlled by whether or not secondary silica effectively sealed some areas from K diffusion.