Appendix 3

Report on the Geology of the Bogo Quarry Site, Bookham

(Rangott Mineral Exploration)

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Rangott Mineral Exploration Pty. Ltd.

REPORT ON THE GEOLOGY
OF THE BOGO QUARRY SITE,
Bookham, NSW,

for the Quarry Production Increase

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October, 2008.

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1.0 INTRODUCTION

At the request of R. W. Corkery & Co. Pty. Ltd., geological mapping of the environs of the Bogo Quarry, located 5.5 kilometres east of the village of Bookham in southern NSW, was carried out between 18th and 20th September, and on 29th and 30th September.

The Bogo Quarry produces concrete and sealing aggregates, pre-coated aggregates, and some roadbase for the civil engineering and construction markets in the broader Yass - Gundagai - Harden region, from a very competent ignimbrite material. The quarry is located on a prominent ovoid hill about 600 metres southeast of the Hume Freeway.

Corkery & Co's brief to RME was to map the geology of the site out to the marked Approved Extraction Limit, and provide information to select the most appropriate area of the site for future development under an expansion programme.

2.0 METHODS

The mapping was carried out at a detailed level, initially by M. Rangott and during the second site visit by M. Rangott assisted by student geologist Aimee Smart. Locational control was obtained by using a Garmin 60CSx hand-held GPS meter, which generally provides x, y accuracies (epes) of 2-5 metres depending on availability of line-of-sight to satellites and the time of day. However, in open locations, coordinates can commonly be repeated within 1 or 2 metres when stations are later re-occupied. No RL (z coordinate) readings were taken, as they are normally of low accuracy in hand-held instruments.

Roughly the first day on site was spent examining the rocks exposed in the quarry faces and rubble piles, as it was believed that those exposures would provide guidance on the rock types and qualities, and structures, over the remainder of the site, which proved to be the case. However, throughout much of the quarry, it was difficult to obtain reliable and complete information due to common clay/dust coatings on rock faces (in part due to recent drought conditions) and rubble piles obscuring some exposures. A general picture emerged, which is discussed in section 3.0 of this report.

Work in the quarry focussed on obtaining structural information (which would be useful for predicting the structure external to the workings) and recording a number of zones of (?)hydrothermal alteration of the rock.

Mapping of the surface area involved delineating reasonably coherent areas (polygons) of outcrop and subcrop (near-outcrop), picking up the main inflection points of the margins of those areas with the GPS metre, then breaking chips and blocks off a representative number of the rock exposures (3-15 sites) within each polygon using a block hammer, so that each defined outcrop area could be classified as fresh, partly (weakly) altered, or altered. Where reliable planar features could be found in outcrop, the strike and dip of those structures were measured with a Brunton Transit and recorded as a separate pickup point in the field book.

All of the pickup points were assigned sequential numbers (total about 1,250) with the prefix 'Q' for sites within the quarry and 'S' for surface sites outside the current quarry boundaries. The serial numbers, MGA-94 eastings and northings, and descriptor codes were later entered by RME personnel, on three data files (lithology, structures and culture) for use in Mapinfo/Discover GIS software. The culture file is only a small file, capturing red-topped star posts (extraction limit points), and some fence posts and gate posts.

The data was plotted by RME GIS personnel Steve Oliver and Kim Bagot after each field trip, and is presented on plans 'A', 'B' and 'C' with this report.

3.0 GEOLOGY

The quarry has been developed within a geological unit known as the Mountain Creek Volcanics, which is a formation of the early Devonian age (deposited approximately 400 million years ago) Black Range Group. The Black Range Group has been mapped from Cooleman Plain near Rules Point to Murringo in the north.

The Mountain Creek volcanics are a sequence of mainly sub-aerial volcanics and sediments laid down during episodes of violent volcanic eruptions during the early stages of formation of the Australian continent. The main rock types are ignimbrites, with some dacite to rhyolite lavas, all of which are very siliceous rocks. The ignimbrites were formed from pyroclastic flows ("nuee ardentes") of very hot gas-supported volcanic debris blasted out of a caldera, which descended around the caldera and travelled across the terrain until they settled on the landscape and welded together. Modern examples of this type of deposit are widespread around the Lake Taupo caldera on the North Island of New Zealand.

Rhyolitic and dacitic ignimbrites and lavas are typically very hard and durable rocks, due to their high silica content and interlocking crystals of various sizes.

The Mountain Creek Volcanic unit, along with adjoining rock units, were folded and strongly fractured later in the Devonian period and possibly also during the Carboniferous period.

In the quarry area, the bedrock is very dominantly comprised of ignimbrites ranging from fine-grained, finely/faintly banded, to a medium-grained fragmental ignimbrite (with clasts up to 1-2cms across) and locally banded, to scattered layers (0.5-2 metres thick) of very coarsely clastic ignimbrite. Some of the larger clasts are haematitic and appear to have been fragments of oxidised (weathered) rock when they were laid down. The coarsely clastic bands are softer when hit with a hammer, and this is believed to be the result of chemical alteration resulting from their greater porosity, and subsequent greater susceptibility to weathering at the present-day land surface.

In the remnant eastern face of the quarry, several very thin (1-10cms) beds of fine-grained rhyolitic tuff or sandstone are exposed dipping at 65° and 73° to the east, confirming the overall orientation of the bedding (see below).

A primary layering (fine banding) is frequently discernible in the ignimbrites, and this is believed to have resulted from the settling of the ignimbrites and subsequent local plastic flow of the welded debris. In the medium and coarser-grained types, the clasts are mainly of rhyolitic/dacitic lavas, pumice and indurated older sediments, and the majority have settled parallel to the primary layering.

As this layering is closely equivalent to bedding in a sedimentary rock, it was mapped as bedding, and was found to almost uniformly strike (trend) north-south and dip to the east at angles between 45 and 80 degrees below the horizontal. At a few locations in the centre of the quarry, the bedding was recorded striking more in the northwesterly direction and dipping to the west-southwest. It is believed that these anomalous orientations are due to either local folding during plastic flow of the ignimbrite as it cooled, or to misidentification by the author.

Cutting across the bedding, at usually high strike angles, are sets of regularly-spaced joints, and sets of fractures (locally intensely developed) which may represent broad fault zones, and a few narrow fault zones lined with rock gouge. The joint and fracture sets usually strike east-west through to southeast-northwest and dip to the south at low to moderate angles. The interaction of the joints and fractures with bedding results in ready size reduction and blocky shapes during blasting.

In the western faces of the quarry, several broad zones of clayey alteration of the ignimbrite are evident. These zones are unusual in that weathering of the rock has extended to greater depths than in the surrounding rocks. However, on closer examination, it is apparent that the clay material within the rock is only partly due (to ?5 metres depth) to weathering, and the weathering has preferentially developed over rocks which were clay altered shortly after formation, by hydrothermal fluids and steam penetrating through the rock fabric (as is commonly seen in the Taupo area).

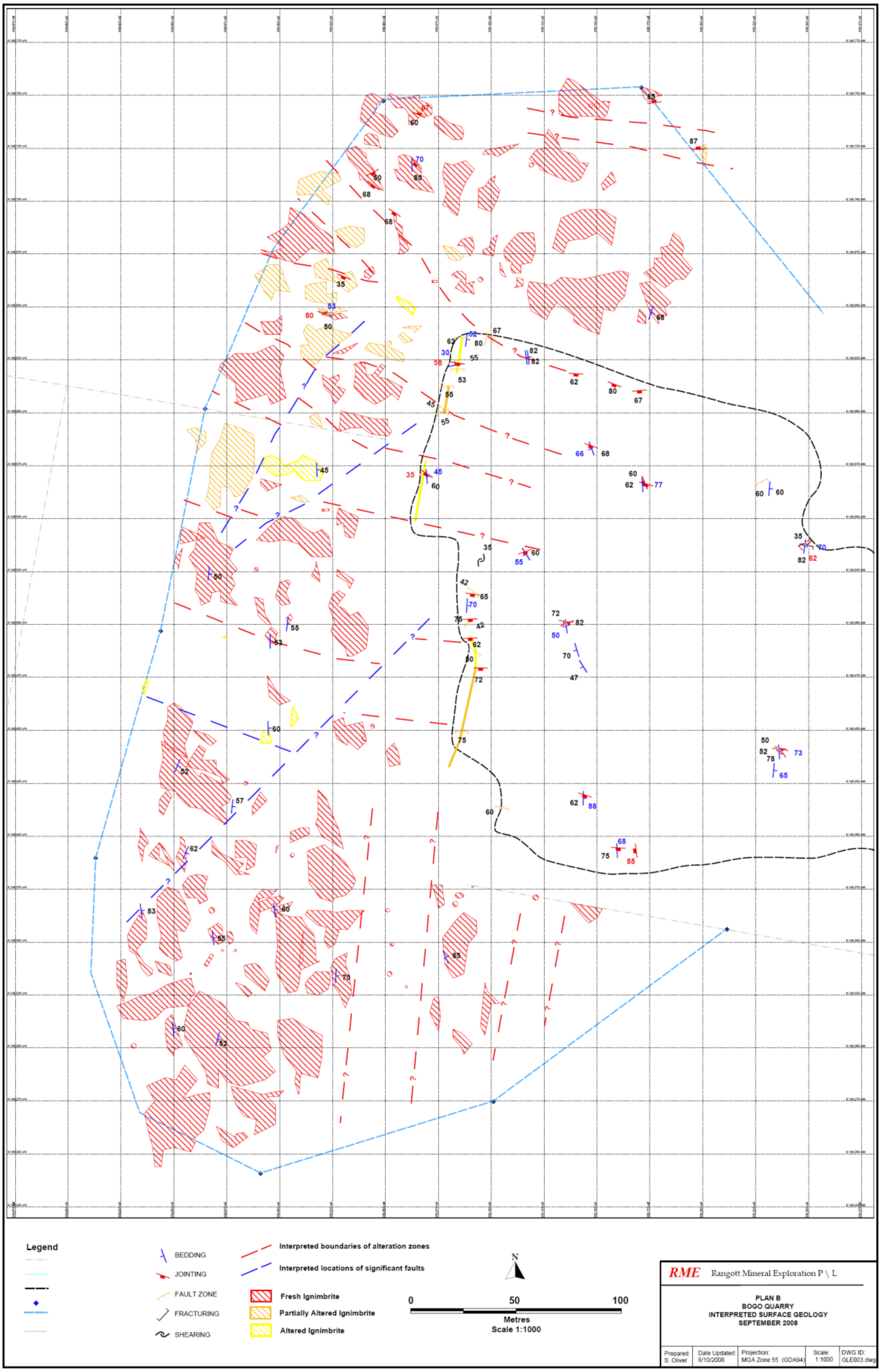
It is not clear what the main clay mineral species are (there being several possibilities) but due to the greasy feel of rock fragments, the writer believes that the main species is pyrophyllite. Pyrophyllite is a clay-like hydrated aluminium silicate mineral which is very stable and mined for use in refractories, ceramics, as a carrier in chemicals, as a filler in mastics, paint, rubber, vinyl, and as an electrical insulator. However, it is a very soft mineral, and its presence would probably significantly reduce the strength and durability of the rock, and lower its ability to bond, i.e. it would be deleterious to both concrete and sealing aggregate applications.

The apparently altered rocks occur in zones of strong fracturing - the dominant set of joints strike approximately east-west and dip to the south at moderate angles (30° to 60°), and where a second set of fractures or small faults is developed (west to southwest striking, 50°-60° dip to south / southeast) the rocks were essentially shattered, allowing hydrothermal solutions to pass through them and strongly alter the rocks.

On Plan 'B', zones of rock interpreted as partly (or moderately) altered are shown as tan bars along the quarry face, and strongly altered zones as lime-green bars. To the west of the quarry face, outcrop areas in which **some** of the rocks are moderately altered or strongly altered are shown by the same colour schemes. The alteration within these outcrop areas is much less extensive than in the quarry faces, but this is believed to be because extensively altered rocks would not outcrop, due to their susceptibility to erode. That is, it is likely that in outcrop we are only seeing the remnants of less extensively altered rock present within those zones.

It is not clear to what depth these zones persist - this could only be determined by drilling a north-south oriented fence of declined drill holes across the interpreted east-west oriented zones. However, the cost of drilling a number of 50-80 metre long holes is probably not justifiable in a quarrying operation of this size.


Legend
Fence
Drainage
Pit Boundary
Star Post
Extraction Limit
655,175mE MGA Zone 55 Coordinates (GDA94)
BEDDING
JOINTING
FAULT ZONE
FRACTURING
SHEARING
Fresh Ignimbrite
Partially Altered Ignimbrite
Altered Ignimbrite
N
0
50
100
Metres
Scale 1:1000
RME Rangott Mineral Exploration P \ L
PLAN A
BOGO QUARRY
FACT MAPPING GEOLOGY
ON AERIAL PHOTOGRAPH BASE
SEPTEMBER 2008
Prepared: S. Oliver
Date Updated: 8/10/2008
Projection: MGA Zone 55 (GDA94)
Scale: 1:1000
DWG ID: GLE002.dwg


Legend
BEDDING
JOINTING
FAULT ZONE
FRACTURING
SHEARING
Interpreted boundaries of alteration zones
Interpreted locations of significant faults
Fresh Ignimbrite
Partially Altered Ignimbrite
Altered Ignimbrite
N
0
50
100
Metres
Scale 1:1000
RME Rangott Mineral Exploration P \ L
PLAN B
BOGO QUARRY
INTERPRETED SURFACE GEOLOGY
SEPTEMBER 2008
Prepared: S. Oliver
Date Updated: 8/10/2008
Projection: MGA Zone 55 (GDA94)
Scale: 1:1000
DWG ID: GLE003.dwg

4.0 ROCK RESOURCES

Surface mapping of the quarry environs (Plan 'B') outlined an area of close-spaced outcrop polygons to the southwest of the quarry. Within these polygons, the percentage of outcropping rock is higher than elsewhere on the site, and the ignimbrite is fresh, unaltered and hard and flinty at the surface. This broad area has been termed Rock Domain 1 (see Plan 'C'), outlined with a heavy blue dashed line.

Disposed north-south across Domain 1 are two 20-35 metre wide bands in which there is almost no outcrop. The reason for the poor outcrop in these bands is not clear - it could be due to alteration of the bedrock, or to the bedrock being bands of coarse clast-rich ignimbrite, which is more susceptible to weathering than the finer, flint-like varieties. As no float of altered ignimbrite was noted in the soil, it is considered unlikely that significant altered ignimbrite is present beneath these bands.

West of the western margin of the quarry, it is interpreted that several broad bands in which the ignimbrite is variably altered, extend out from the quarry faces to the north and northwest (Domains 2 and 4). Outcrops within these bands are limited, and are mainly of weakly to moderately altered ignimbrite. It is likely that the intervening material is more intensely altered and weathered. The weathered and altered material would have value for use as a plasticiser in roadbase production, and this material has been successfully sold to that market application in recent years.

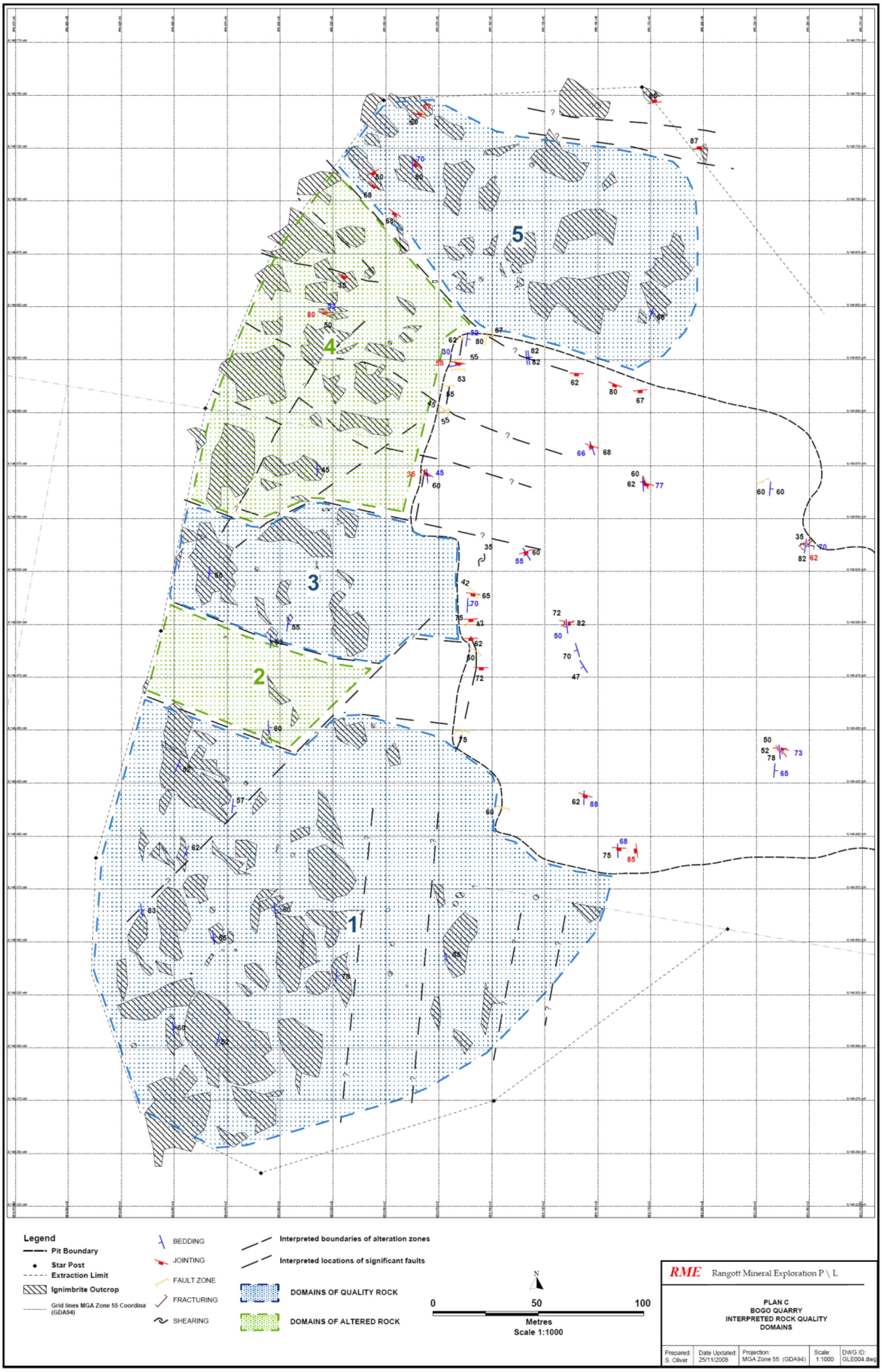
A smaller area of indicated largely unaltered and therefore higher quality rock is outlined as Domain 3 on plan 'C'.

To the north of the northern margin of the quarry, a third, large area of interpreted mostly good quality rock for aggregate production, has been outlined as Domain 5. The author's impression during mapping was that the density of fresh rock outcrops within the polygons in this domain is lower, and some small areas of partially altered ignimbrite were noted within them, so it is considered that Domain 5 would produce a higher proportion of altered rock than Domain 1.

The altered material should be kept separate from the unaltered ignimbrite during extraction, and separate resource tonneages calculated for the two rock quality types.

Ron Hearne has advised that the RTA carried out some mapping and shallow (?percussion) drilling in the vicinity of Domain 5 during the 1970s and 1980s. It would be useful if a copy of the report on the drilling results could be obtained to check the RTA's assessments of rock quality, but if the holes were drilled vertically and to only shallow depths (10-15 metres), the information gained from it would probably not be sufficiently representative of the rock within the domain.

We were unable to map a small triangular area located immediately to the east of Domain 5 due to lack of time towards the end of the second site visit, but it is possible that rock exposures in this area would be similar to those in Domain 5.


1
2
3
4
5
Legend
Pit Boundary
Star Post
Extraction Limit
Ignimbrite Outcrop
Grid lines MGA Zone 55 Coordina
(GDA94)
BEDDING
JOINTING
FAULT ZONE
FRACTURING
SHEARING
Interpreted boundaries of alteration zones
Interpreted locations of significant faults
DOMAINS OF QUALITY ROCK
DOMAINS OF ALTERED ROCK
N
0
50
100
Metres
Scale 1:1000
RME
Rangott Mineral Exploration P \ L
PLAN C
BOGO QUARRY
INTERPRETED ROCK QUALITY
DOMAINS
Prepared: S. Oliver
Date Updated: 25/11/2008
Projection: MGA Zone 55 (GDA94)
Scale: 1:1000
DWG ID: GLE004.dwg

5.0 RECOMMENDATIONS

As a result of this surface study, it is recommended that:-

(i) a resource be calculated for Rock Domain 1, and that future development of the quarry for aggregate production be directed at extracting the rock in this domain.

(ii) XRD (X-Ray Diffraction) analyses be carried out on a least two specimens of the argillically altered ignimbrite, to determine the clayey mineral species present and their probable genesis. The estimated cost of this work is about $500.

(iii) continue to make efforts to obtain copies of the RTA's report / data.

(iv) check geological reviews (or mapping, if warranted) of the site (1-2 days work) be undertaken at six or twelve month intervals, to monitor geological developments and deal with any rock quality issues, as quarrying proceeds.

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