An Unusual Contact – Whitford Quarry, Whitford

Introduction

The Whitford Quarry, located some 6km south of the Beachlands settlement in east Auckland, is operated by Fulton Hogan Ltd. Resource primarily in the form of 'greywacke' rock, is actively being extracted from the quarry, crushed and sold as aggregate.

The quarry is located in close proximity to a large fault (Waikopua) and has overlying younger sediments that mantle the resource rock.

Riley Consultants Ltd has been involved in stability assessment of existing and proposed cuts and excavations within the quarry. During our inspections of the cut faces the geological contact between the older 'greywacke' and considerably younger overlying sediments has been exposed at several locations.

This article presents a brief summary of the nature of the contact including cursory observations and stability characteristics of the geological units in proximity to the contact.

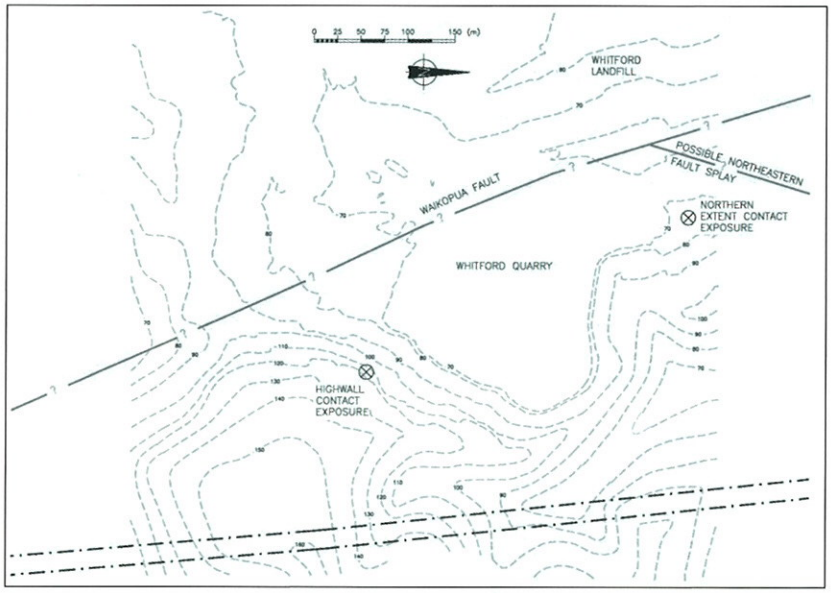

Figure 1: Plan of relevant features at Whitford Quarry

Geological Environment

The Whitford Quarry has been developed in sheared, argillite dominated rock of the Waipapa Group. This material at Whitford is typically referred to as 'greywacke', however this term is more accurately applied to coarser grained materials, such as indurated sandstones. For consistency with other publications and reports, the quarried material is referred to as greywacke within this article.

The quarry is generally being excavated eastward into relatively steep bush covered terrain. To the west is gentler terrain, including the artificial hill of the Whitford landfill (which will eventually backfill the quarry). Figure 1 shows the location of key elements.

At the quarry the rock has a cataclasite texture and primary bedding is difficult to discern. Where bedding is rarely discernable it is typically steeply dipping at 60°+.

The Waikopua Fault borders the uplifted greywacke of the Maraetai hills and defines the western extent of the quarry resource. The fault crosses the existing quarry floor and at the present time broadly divides the quarry from the adjacent landfill (which is developed on Waitemata Group deposits). Drilling results and geological mapping indicates there is a possible obscured fault zone passing northeast through the northern corner of the quarry, however this has not been directly observed.

Overlying the greywacke around the periphery of the quarry is younger Waitemata Group deposits, typically comprising alternating beds of sandstone and mudstone of the East Coast Bays Formation (ECBF). Separating the ECBF from the underlying greywacke at Whitford quarry is typically a variable thickness of highly weathered Cape Rodney Formation (CRF) consisting of a pebbly conglomerate in a silty sand matrix up to 4m-5m thick.

Greywacke/Waitemata Group Contacts

The contact between Waipapa Group (greywacke) and Waitemata Group is naturally exposed in several locations along the margins of the mainland and islands of the Hauraki Gulf. This includes Leigh and Tawharanui on the mainland, along with Kawau, Motatapu and Motuihe Islands. Other locations also exist. However, these contacts are not within an active quarry.

Although not studied in detail by the author, the contact between greywacke and basal Waitemata Group at the above listed sites typically comprises an undulating greywacke top, punctuated by old sea stacks, with depressions filled and overlain by pebbly in-fills (CRF). Overlying this is generally sandstones and mudstones of the ECBF or Pakiri Formation (a unit similar to ECBF).

At the Whitford quarry the contact between greywacke and overlying units has been observed at two locations (excluding drillholes). The first near the crest of the 60m tall highwall, whilst the other is at the quarry's northern end, adjacent to the Waikopua Fault, where stripping operations have been recently performed.

Figure 2: Exposure near crest of highwall in 2005. Geologist is picking at white chalky material whilst standing on highly weathered greywacke rock. Above is pebbly Cape Rodney Formation.

Figure 3: Exposure at northern extent of quarry showing dipping weathered greywacke, the top of which is marked by dark greenish colouration. This is overlain by mixed deposits including dark brown silt, which is apparently unconformably overlain by Cape Rodney Formation. The Waikopua Fault is some 90m to the west (left).

Highwall

At approximately RL120, near the highwall crest, highly to completely weathered greywacke rock is overlain by CRF. The contact is gently undulating, though would appear to have an overall gentle dip to the north (6° to 8° northward based on structural contouring).

Interestingly, during excavations in 2005 an unusual exposure was created of approximately 1m-3m of CRF overlying a unit of weathered sand. This lensoidal sand ranged in thickness from 0.0m to 0.6m and appeared to be infilling a palaeo erosion surface on the weathered greywacke below, but also possibly inter-fingering with the CRF at the extremities (although this is uncertain due to limited access). Within the sand were lenses of a white chalk like material up to 0.15m thick. The 'chalk' contained pockets of carbonaceous material up to 5cm thick and 30cm in length. These pockets contained unusual rounded pebbles, inferred to be weathered sandstone. This material extended some 20m laterally and is shown in figure 2.

Quarry Northern Extent

Recent excavations at the northern extent of the quarry have exposed the contact between the greywacke and overlying units as shown in figure 3. This can be compared against the limited exposure in the current highwall as discussed above. The greywacke has an undulating palaeo-surface with apparent channel infill and beds of dark brown (possibly carbonaceous) silt, similar to that observed in Waikato Coal Measures (Te Kuiti Group) seen in Papakura. Also included are apparent rounded greywacke gravels (often with a yellowish sulphur colouration). This sequence is no more than 1m thick over the exposed section with carbonaceous beds dipping sub-parallel with the greywacke interface. It appears to have an undulating, unconformable contact with the overlying CRF pebbly beds above, with an average interface dip of 22° to the northwest. Within the CRF were organic silt horizons with a bed dip of approximately 6° northwest.

The upper, completely weathered greywacke had a greenish colouration, which is unusual compared to other current Whitford Quarry exposures.

Te Kuiti Group?

Previous investigations at the quarry, e.g. GF Industrial Geology 2000, have speculated on the possible presence of isolated Te Kuiti Group deposits around the Whitford Quarry.

The materials recently encountered in the northern faces and highwall share similarities with some Te Kuiti Group deposits. The presence of Te Kuiti Group deposits is known in Papakura some 15km south of the quarry and also in deep coring under Auckland city isthmus and Ardmore, however the author is unaware of any occurrences recorded near-surface in the Whitford-Clevedon area.

It is also considered plausible the described deposits are constituent members of the CRF or the larger Kawau Subgroup as defined by Kermode 1992 and Edbrooke 2001.

The carbonaceous bedding dip within the subject material is sub-parallel with the eroded greywacke surface. That this dip is unconformable with the overlying sequence is another interesting aspect. The relative close proximity of the Waikopua Fault may have an influence, through drag effects, on the bedding angles. It should be noted however, judging bedding dip from organic rich layers may not always be reliable.

Massive ECBF sandstone units in the immediate vicinity of the CRF at the northern extent of the quarry have

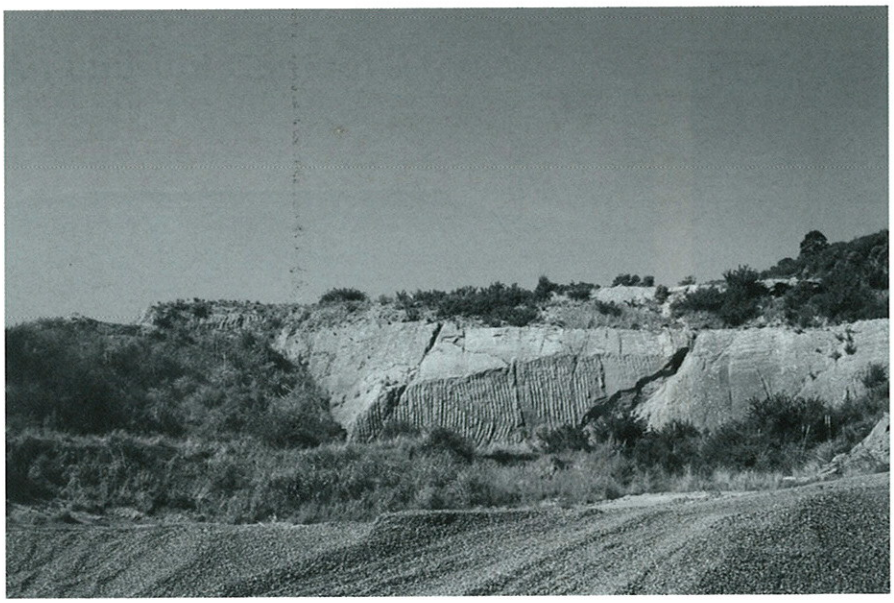

Figure 4: Steeply cut Cape Rodney Formation at the northern extent of the quarry.

an unclear relationship to the CRF exposure. It has been previously postulated by others that a northeast striking fault is present in the area and this may somewhat explain the uncertainty.

It is unclear from published information whether Kawau Subgroup has internal unconformities that would give rise to such divergent bedding dips.

Geotechnical Properties

Whilst pondering over the geological relationships is all very interesting, the materials exposed have to be worked to form a quarry or landfill.

With respect to the highwall exposure limited tri-axial testing was performed on the weathered basal ECBF sandstone beds and also the underlying CRF recovered from core. For the ECBF results of c'=15kPa and ø'=32° were achieved, whilst for highly weathered CRF a single test gave c'=42kPa and ø'=31°. Such parameters are consistent with back-analysed numbers.

Stability

CRF can be battered at relatively steep angles of up to approximately 70° to heights of 3m-4m as shown in figure 4 and exhibit good stability. The batter at the quarry shown in figure 4 has shown relatively excellent stability for at least 5 years with one minor failure along an apparent major joint.

This excellent stability characteristic is thought to be primarily attributable to relatively high strength and superior drainage.

The contact between the greywacke and overlying materials could potentially act as a failure plane. In the Whitford Quarry this contact is typically undulating and rough. Also, the orientation of the contact has not yet been unfavourable to stability; however this could change with further highwall excavation.

Summary

The contact between basal Waitemata Group and underlying greywacke deposits is currently exposed at 2 locations within the Whitford Quarry. In both situations unusual deposits or structures have been observed adjacent to the interface. It is uncertain whether these deposits relate to Te Kuiti Group or perhaps Kawau Subgroup, of which Cape Rodney Formation is a member.

In cut, the highly weathered Cape Rodney Formation typically performs well due to relatively high strengths and a freer draining characteristic than adjacent materials. The Cape Rodney material would appear to be affected mildly by jointing.

References

Edbrooke, S; 2001: *Geology of the Auckland Area.* IGNS

GF Industrial Geology Ltd; 2000: *Assessment of Rock Quality at Whitford Quarry.* For GHD Ltd

Kermode, L: 1992: *Geology of the Auckland Urban Area. IGNS.*

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