Geology of the Wharekirauponga Epithermal Gold Deposit, Coromandel Region

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ABSTRACT

At Wharekirauponga epithermal precious metal mineralisation is hosted by a system of complex, steeply dipping quartz veins in flow-banded rhyolites and intercalated rhyolitic tuffs.

The host rhyolites occupy a narrow north-northeast trending graben within a regional north-northeast belt of transcurrent faulting. The rhyolites are intruded by a pre-mineralisation andesite dyke which is preferentially more strongly veined and mineralised.

Hydrothermal alteration is zoned around a central core of quartz-adularia (+230°C), with a peripheral and partly overprinting zone of interlayered illite-montmorillonite (180°C). A broad zone of acid alteration characterised by cristobalite-kaolinite-montmorillonite (c.150°C) extends to the north and south of the inner zones.

Low-order gold mineralisation (up to 0.25 ppm) is disseminated through the rhyolites and tuffs in the central quartz-adularia zone. Higher grades of mineralisation are confined to complex quartz veins comprising multiple bands of brecciated, chalcedonic, and granular quartz. The gold occurs in individual bands within the veins as submicroscopic (less than 1 micron) clusters and rare larger grains (less than 30 microns).

Limited fluid inclusion data from the complex veins suggest the gold-silver mineralisation was deposited at between 240 and 280°C; the fluids were apparently gas-rich and boiling may have occurred at the higher temperatures.

The close association of the andesite dyke intrusive with the strongest alteration, quartz vein development, and gold-silver mineralisation strongly suggests a co-genetic relationship.

Keywords: Coromandel region; epithermal; gold-silver; rhyolites; Wharekirauponga.

INTRODUCTION

The Wharekirauponga prospect, situated in the southeastern part of the Coromandel Range 11 km south-southwest of Whangamata, is an epithermal quartz vein stockwork system in graben-filling rhyolitic flows and tuffs. The mineralisation is extensively exposed in a deep gorge cut by the Wharekirauponga Stream into strongly silicified rhyolites.

The area was prospected by numerous adits at the turn of the century, but no significant production eventuated. Recently the potential of the prospect has been reinvestigated by surface mapping, geochemical and geophysical surveys, and three diamond drilling programmes.

Early investigations on the prospect are described by Bell and Fraser (1912) and Downey (1935). This paper is based mainly on recent information obtained from surface mapping and diamond drilling work (Barker, 1982; Barker et al., 1980; Moore, 1985).

GEOLOGICAL SETTING

Wharekirauponga lies near the southern part of the Coromandel region, a north-northwest trending belt of subaerial Neogene intermediate to acid volcanics overlying a basement of Mesozoic greywackes. The volcanics are products of Benioff zone magmatism in a continental margin arc environment that has been active since the early Miocene. They range from andesitic to rhyolitic composition, the younger rhyolites having more extensive occurrence in the east and southeast, where they infill graben-type structures.

The prospect lies on the eastern side of a broad belt of regional NNE faulting, extending from Te Aroha in the southwest to Opoutere in the northeast. This belt may represent a major focus of dextral transcurrent and rifting movements, and hosts major epithermal quartz vein deposits at Te Aroha, Karangahake, Waitekauri, Golden Cross and Ohui (Fig. 1). Subordinate WNW to NW crosscutting fault trends occur at intervals along the NNE fault belt, and may have a significant role in localising the development of the vein deposits. One of these crosscutting NW structural features, defined by mapped faults and alignments in ground and aeromagnetic anomaly patterns, occurs in the immediate vicinity of the Wharekirauponga mineralisation.

LOCAL GEOLOGY

The vein stockwork system at Wharekirauponga occurs within intensely hydrothermally altered flow banded to spherulitic rhyolite flows and tuffs of the Whitianga Group, which are probably

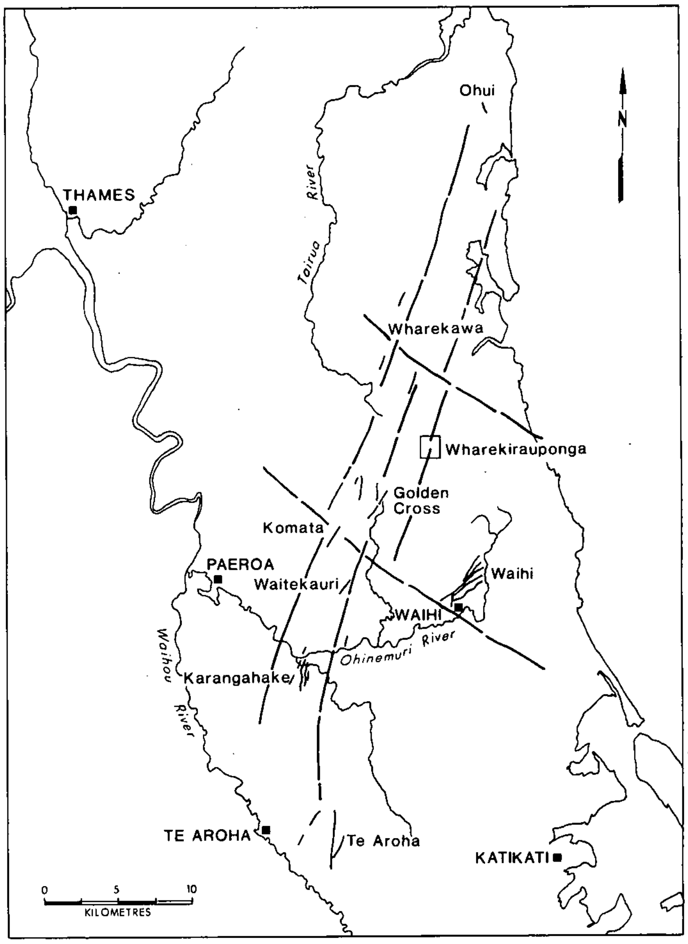

Fig. 1 — Generalised location map.

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of mid-Pliocene age (Skinner, 1986). These infill a north-northeast trending graben structure within a generally dacitic volcanic sequence, and are exposed in the gorge section of Wharekirauponga Stream. The older dacitic units are overlain to the west and south in the headwaters of the Wharekirauponga valley by younger unaltered andesitic-dacitic flows of the Omahia Andesite (Barker, 1984). Locally the Omahia Andesite also forms intrusive plugs and domes. It is probable that these younger flows were originally much more extensive, and have been largely eroded from the main valley area.

The graben boundary faults strike between north-northeast and northeast, with a series of northwest-striking faults cross-cutting the rhyolites near the southern end of the gorge section at the confluence of Edmonds and Teawaotemutu Streams (Fig. 2). Several northwest faults are also present to the north of the gorge section. Within the graben bounded by these north-northeast and northwest structures there is a strongly developed set of north-south trending fault and fracture zones transecting the graben diagonally. Most of these faults are in a belt lying immediately east of the gorge, and dip steeply to the west; but in a subordinate fault zone west of the gorge, dips are steeply easterly. The strongest vein development is within the belt of country lying between these two faults zones.

Flow banding attitudes within the rhyolite sequence infilling the graben are remarkably consistent, with a predominantly east-northeast to east-west strike and southerly dip. Dips steepen progressively southward in the gorge section from low to moderate (15-45°) through to near vertical (80°), while at the south end of the gorge the dip is steeply north. This pattern suggests extrusion of the rhyolite into the graben structure from east-west aligned fissure vents located near the present confluence of Edmonds and Teawaotemutu Streams. Several east-northeast faults occur here.

In the northern end of the gorge section the rhyolites are intruded by a north-northeast striking andesite dyke which is also altered and mineralised. It has a chilled frozen contact with the host rhyolite. Petrographically it differs from typical Omahia Andesite units, and it presumably relates to an earlier episode of andesitic intrusion post-dating the main rhyolite stage but pre-dating the main phase of hydrothermal alteration and mineralisation. In this respect it is comparatively unusual in the Southern Coromandel region where post-main-rhyolite, pre-mineralisation andesitic (intrusive) units have not elsewhere been recognised.

Most of the area away from the gorge is blanketed by a layer of Recent andesitic-rhyolitic ash, usually less than 3 m thick.

ALTERATION

Hydrothermal alteration appears to be zoned around a central core of silicification in the rhyolites in the south-central part of the gorge section. However establishment of the zone pattern is hampered by poor outcrop and thick recent ash cover away from the gorge and main valley.

Alteration in this central zone is characterised by a quartz-adularia + retrograde illite assemblage (+230°C) in a zone approximately 50 m wide and elongated north-south, with a strike length of approximately 450 m. To the south the silicified zone terminates in the vicinity of several northwest-striking faults. The andesite dyke lies within the northern part of this zone and exhibits strong potassic alteration.

There appears to be an increase in pyrite concentration on the margins of the quartz-adularia zone.

Several deep drillholes in the central part of the gorge section show alteration and veining becoming weaker with depth. Below a horizon of approximately 50 m below sea level, the quartz-adularia alteration gives way to a propylitic assemblage with chlorite and minor adularia. There is an accompanying decrease in low-order gold content.

The quartz-adularia zone is bounded to the south by an intermediate zone of interlayered illite-montmorillonite alteration (c.180°C), partly peripheral to and partly overprinting the quartz-adularia assemblage. Beyond this an upper acid leach zone characterised by cristobalite, kaolinite and montmorillonite (c.150°C) extends south to (and presumably beneath) the contact with the overlying unaltered andesites (Barker, 1984). A similar gradation through moderately altered quartz-illite rhyolites to intensely kaolinised rhyolitic tuffs occurs to the northeast of the gorge section.

The interlayered clay and capping acid kaolinite zones have been interpreted (Barker, 1984) as possibly significantly younger than the quartz-adularia alteration, but their disposition around the central quartz-adularia zone suggests they are peripheral parts of the same system. The interlayered clay overprint on the quartz-adularia assemblage could be a retrograde effect as hydrothermal activity declined.

A warm spring is located on the true right bank of the main stream approximately 200 m below the gorge section. Its presence supports the possibility of episodic alteration over an extended period of time.

MINERALISATION

Gold-silver mineralisation occurs extensively within and on the margin of the central zone of silicification. Most of the significant mineralisation is hosted by veins, but there is also widespread low order disseminated gold in the rhyolites. The andesite dyke is significantly more strongly mineralised than the host rhyolites.

The strongest development of quartz veining is in the central gorge section from north of the Edmonds-Teawaotemutu confluence to the prominent east bend in the main stream. Most of the veins here strike between north-northwest and north-northeast and dip steeply west (Fig. 3).

Both simple and complex vein types occur. The simple veins are generally less than 10 mm wide and have been formed by a single phase of introduction of silica. Complex veins range from a few centimetres to over 1 m in width, though most are less than 20 cm wide. They comprise multiphase banded quartz, including granular, fibrous, drusy and chalcedonic varieties; rare rhombic adularia is also present. Minor pyritic or limonitic bands also occur. The main opaque phases are pyrite and limonite, with trace amounts of arsenopyrite, chalcopyrite, and secondary covellite, digenite and hematite. Gold occurs only in the complex veins, and is generally confined to one or occasionally several distinct individual bands within the vein, which are sometimes pyritic, though not always. However it is not unusual for none of the bands in a particular vein to be auriferous. The gold is present mainly as clusters or clouds of submicroscopic (less than 1 micron) grains, but rarely larger grains (less than 30 microns) occur free or included in pyrite, chalcopyrite aggregates, or limonite.

Fluid inclusion homogenisation temperatures determined on a limited range of samples from complex veins in drill cores within the quartz-adularia zone range from 190 to 280°C. Most temperatures are in the range 200-230°C. Significantly different temperatures can occur in individual samples, and conversely similar temperatures occur at widely differing depth. Lower temperatures within the same sample probably represent later fluids trapped as the system declined. Alternatively the varying temperatures could be due to boiling and trapping of a non-homogeneous fluid. No evidence of boiling in the inclusions studied was observed, though boiling could still have occurred during brecciation and chalcedonic quartz deposition. Preliminary studies by Dr. A.B. Christie (pers. comm.) have shown evidence of boiling, and suggest the fluids were gas-rich.

GEOCHEMISTRY

Gold grades within the central quartz-adularia mineralised zone appear to fall in three populations, on the basis of cumulative

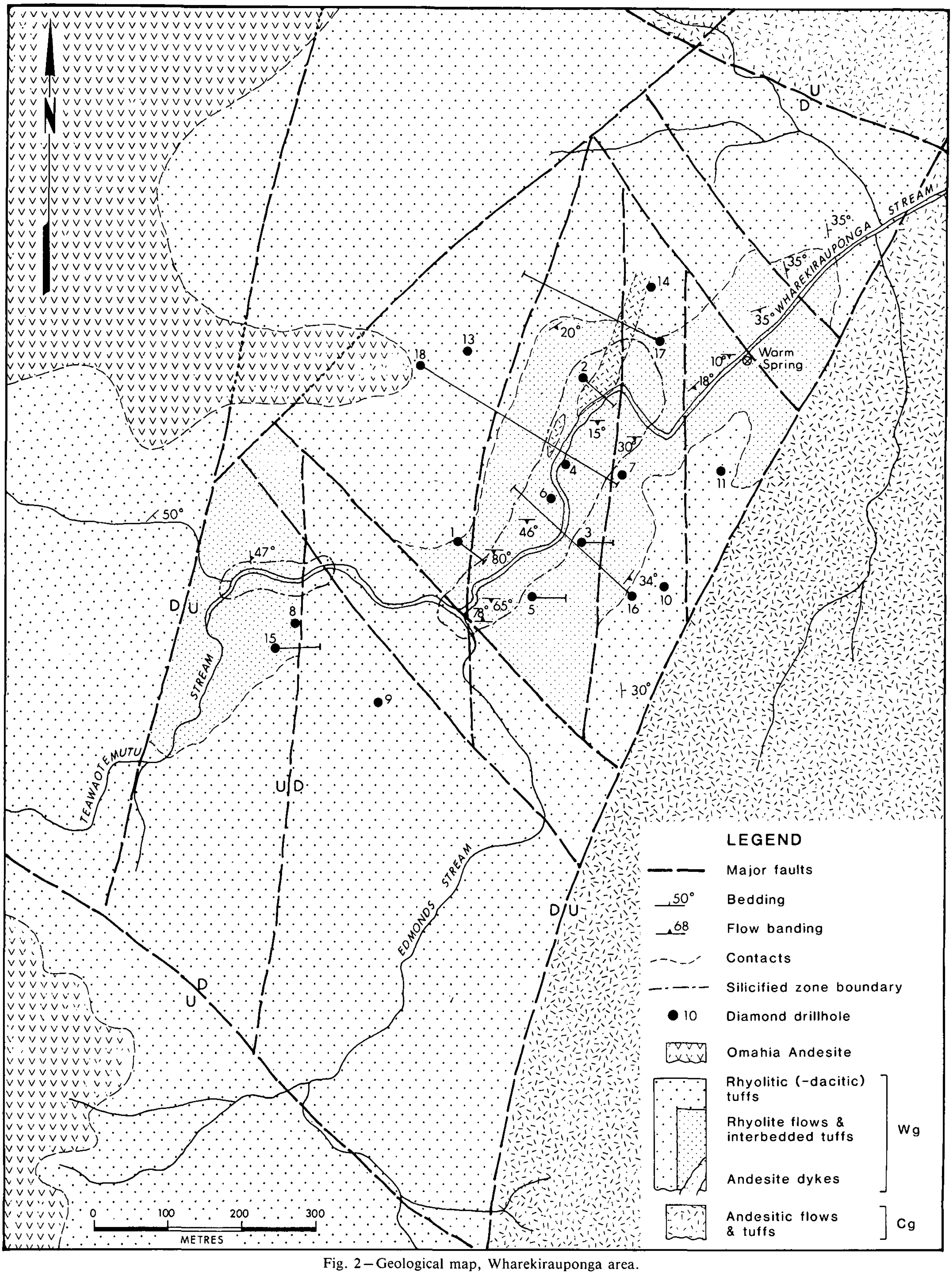

Fig. 2—Geological map, Wharekirauponga area.

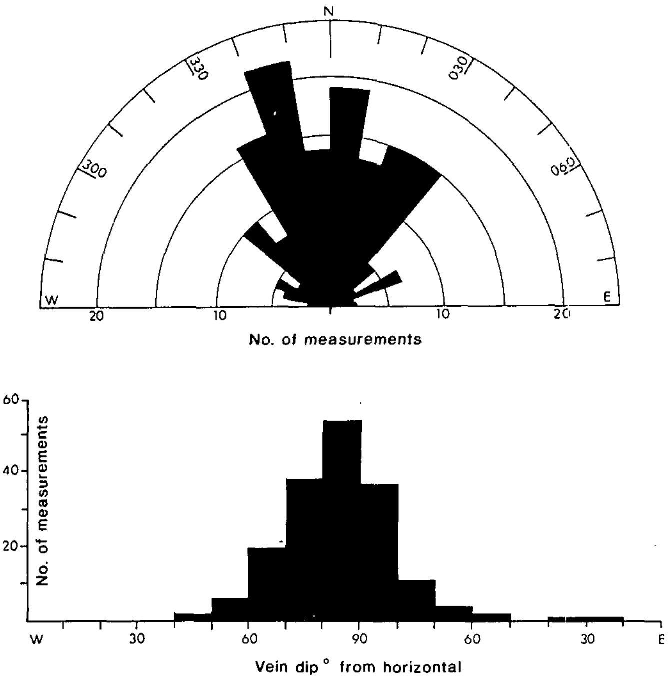

Fig. 3 — Vein orientations and attitudes in gorge section.

frequency curves (Fig. 4a). Changes in slope occur at 0.25 ppm and 1.5 ppm. The highest-grade population (+ 1.5 ppm Au) correlates well with the presence of complex quartz veins. However the reverse is not always true, i.e. complex quartz veining is not always accompanied by significant gold mineralisation. Complex-style veining thus appears to be a necessary, but not sufficient, condition for high gold values.

Silver only shows one change in slope, at 3 ppm (Fig. 4b), with silver levels above this figure correlating closely with high gold values. Silver to gold ratios vary from 0.7 to 5, with the majority in the range 1.5-2.5. The ratio is lowest (0.7) in samples with high gold contents (+ 10 ppm), and highest where gold content is intermediate (4-6 ppm). There is a strong trend of decreasing silver:gold with depth, from more than 2 to less than 1, due largely to an increase in gold content at lower elevations (below 50 m a.s.l.). There is also a decrease in Ag:Au from south to north, suggesting the system is centred in or north of the northern part of the gorge section.

Distribution of arsenic is complicated by mixing, but three populations are apparent in Fig. 4c. A population with levels of less than 80 ppm is coincident with areas essentially barren of gold-silver mineralisation. However some gold-bearing veins coincide strongly with low arsenic levels. A middle population of values between 80 and 400 ppm arsenic correlates with the broadly dispersed low-grade gold mineralisation (below 0.25 ppm Au). Arsenic levels exceeding 400 ppm are confined almost exclusively to the andesite dyke, and to a deep-level pyritic fracture zone.

Antimony levels are generally low; they appear to be weakly elevated immediately outside the main zone of gold mineralisation, forming a halo broadly coincident with the zone of higher pyrite concentration. Higher antimony levels also occur in the high-arsenic deep pyritic fracture zone. Significantly auriferous sections, such as through the andesite dyke, contain no detectable antimony.

Base-metal contents are uniformly low, with maximum levels for copper, lead and zinc of 29, 25, and 70 ppm respectively. Such low values strongly suggest that the level of current exposure of the deposit is within the upper part of the original epithermal system.

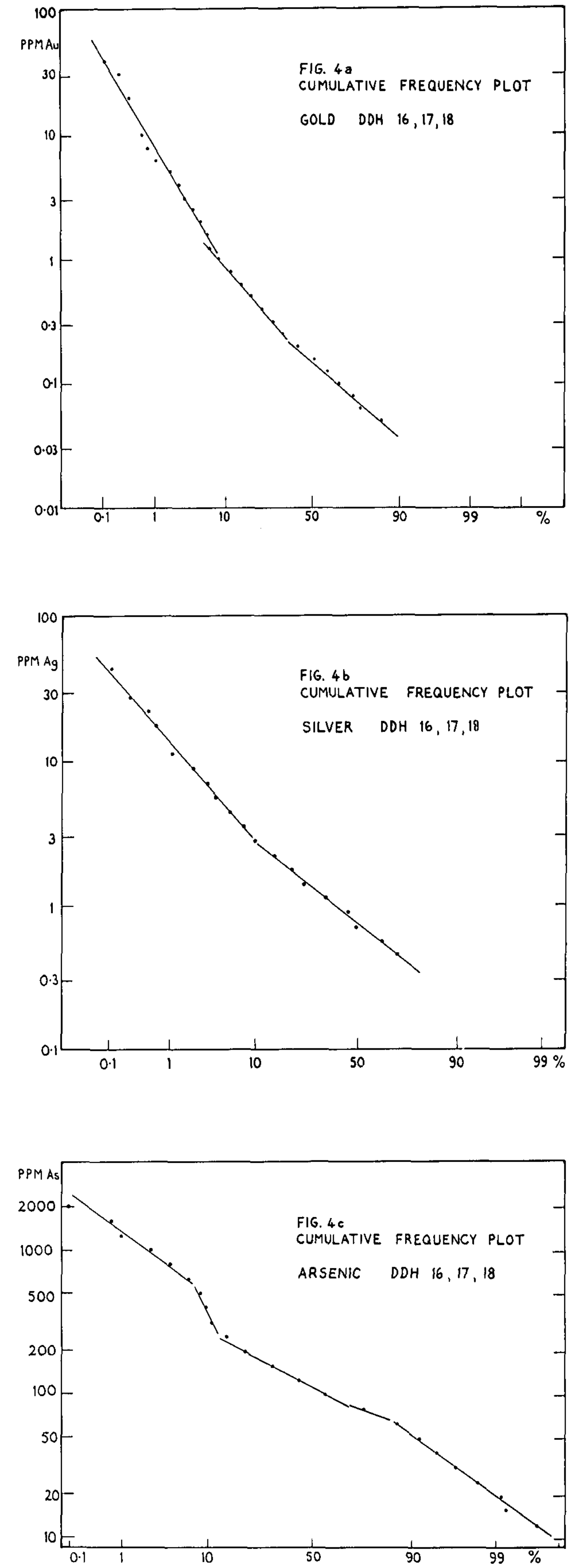

Fig. 4 — Cumulative frequency plots for gold, silver and arsenic in DDH 16, 17, and 18.

SUMMARY

Hydrothermal mineral assemblages and zonal distribution at Wharekirauponga are typical of epithermal volcanics-hosted precious-metal quartz vein deposits in the Coromandel region.

The mineralisation is located where crosscutting northwesterly structures intersect a major zone of north-northeasterly faulting running from Te Aroha in the southwest to Opoutere in the northeast.

Temperatures from alteration mineralogy and fluid inclusion data suggest the intermediate part of the deposit is currently exposed in the gorge area, with overlying acid alteration largely removed by erosion. Advanced argillic-type alteration assemblages exposed north and south of the gorge may be peripheral parts of the original alteration system, or could be related to a significantly younger event.

The deposit is comparatively somewhat unusual in being hosted by flow-banded rhyolites and rhyolitic tuffs intruded by a late-stage pre-mineralisation andesite dyke, with which the strongest mineralisation (in terms of both gold grades and intensity of quartz veining) is preferentially associated. The strike of the larger veins is sub-parallel with the dyke intrusive.

In this respect a reverse analogy with the Komata deposit is of interest, where the vein zones are hosted by a flow-banded north-northeast striking rhyolite dyke intrusive within andesitic-dacitic flows and tuffs.

A causal relationship may well exist at Wharekirauponga between the intrusive and the mineralisation. A possible development model for the deposit is outlined as follows:

1. dextral transcurrent movement on a broad NNE fault belt
2. graben development between two NNE boundary faults; WNW cross faulting; extrusion of rhyolitic volcanics
3. further (?dextral) transcurrent movement on boundary faults, leading to development of a transverse N-S to NNE fault/fissure zone within the graben block; intrusion into this zone of the andesite dyke from a deep-seated magmatic source
4. development of a geothermal system initiated and maintained by the magmatic intrusive heat source; concurrent rejuvenated fracturing in the graben block following the original zone of dyke intrusion; deposition of quartz veins and accompanying hydrothermal alteration
5. waning thermal activity; minor weak resurgence, leading to overprinting/marginal development of acid low-temperature alteration assemblages (the presence of a warm spring at the present day suggests the latter event is distinctly probable).

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Fluid inclusion results presented were determined by KRTA. XRD analyses and quartz vein mineragraphy were carried out by C.J. Alenson and W.H. Ringenbergs respectively, both of BHP.

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