

Gismondine and Associated Zeolites from Aranga, Northland, New Zealand

Susan F. COURTNEY¹

Abstract Clear and chalky varieties of gismondine are described from vesicles and small dykelets penetrating a basic andesite flow in the Aranga area of Northland, New Zealand. X-ray diffraction, Fourier transform infra-red and thermal data are used to characterise these two varieties (clear and chalky). Results show that despite differences in physical appearance there appears to be no significant chemical difference between the two varieties. However, the chalky variety contains more low-temperature water, has more Al and less alkalies than the clear variety.

Key words: gismondine, zeolites, physical data, FTIR, thermal and chemical data, basalts, New Zealand

INTRODUCTION

The voluminous Miocene arc-type volcanic rocks of Northland provide some of New Zealand's best localities for collectors of zeolites and many species have been recorded (Railton & Watters 1990). In 1985 an amateur mineralogist, Mr. Neville Berkahn, observed some crystals which he could not identify in specimens collected from Hood Road quarry (O07/632073), at Aranga in Northland, and gave them to Professor Teruhiko (Terry) Sameshima for him to identify. Terry tentatively identified the mineral as gismondine. Gismondine is a rather rare zeolite (Gottardi & Galli 1985). One gismondine locality had previously been recorded in New Zealand, in a calc-hornfels (Baker & Black 1980), but the Aranga gismondine is the first New Zealand record of hydrothermal origin in volcanic rocks. Regrettably, Terry Sameshima never published his description and the specimens remained in his collections and came to Auckland University upon his death. This and additional material collected by the present author provide the basis of the descriptions in this paper.

The volcanic rocks, in which the Hood Road quarry is located, are basalts and basic andesites of the Waipoua Basalt formation. Waipoua Basalts characteristically occur as thin extensive flows separated by hyaloclastite beds and cut by feeder dykes, and collectively form a geomorphic feature referred to as the Tutamoe Plateau (Wright 1980). The Hood Road quarry is located on the south

western end of the plateau (Fig. 1) and is sited in a single flow of an augite-olivine basalt which has been intruded by thin (<2m wide) feeder dykes of basalt.

The lava flow is normally a light grey coloured rock and strongly porphyritic with phenocrysts, up to several mm long, of augite and plagioclase and small (<0.5mm long) crystals of olivine which are oxidised and rimmed with brown iddingsite. The groundmass of the lava is very fine grained and contains feldspar needles, pyroxene granules and finely disseminated iron oxides, with interstitial devitrified glass, and patches of saponite. Locally, close to the edges of the flow, the rock is highly oxidised and bright red in colour. The dyke rocks are dark coloured, nonporphyritic and holocrystalline augite basalt with a doleritic texture. The dyke rock contains considerably more saponite than the lava but lacks extensive zeolitisation.

ZEOLITES AND ASSOCIATED MINERALS

Zeolites occur in druses, encrusting joints and penetrating the basalt lava flow as thin dykelets.

Thin section of the lava revealed that all the feldspar phenocrysts showed incipient alteration to zeolites along fractures and cleavages. Although saponite occurred in the rock it did not line vesicles and the zeolites in druses and dykelets crystallised directly on minerals in the rock.

Specimens were first examined with a stereo mi-

¹Geology Department, University of Auckland, Private Bag 92019, Auckland, New Zealand.

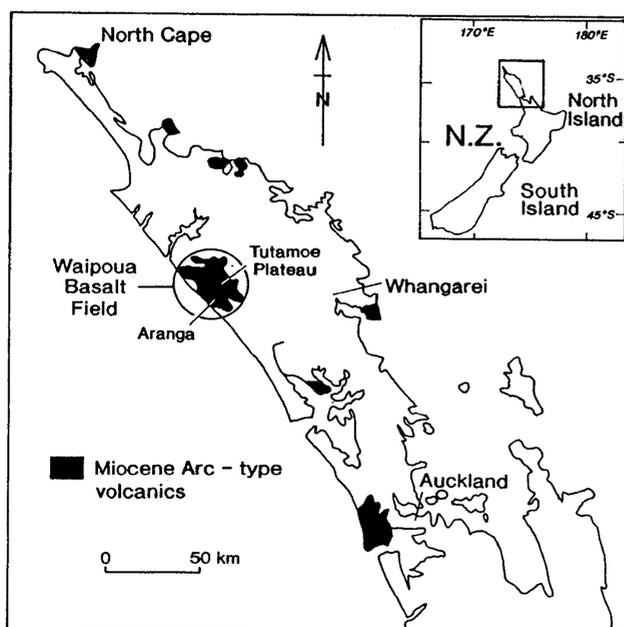


Fig. 1 Locality map for the Waipoua Basalts and Aranga area.

crosscope then individual zeolite crystals were removed and identified by X-ray diffraction methods using a Phillips PW1050 goniometer fitted with a graphite monochromator; Sietronics SIERAY 112 software supported the system.

The most extensive zeolitisation occurs in the lava where the following minerals occur:

Calcite occurs either as scalenohedrons or "saddle"-shaped clusters forming spheroidal structures. While the scalenohedral form appears always to be early and to form a core on which later zeolites grow, calcite has crystallised throughout the paragenetic sequence and is also the final phase.

Chabazite, which has a typical rhombohedral form, occurs as single untwinned crystals and as interpenetration twins. This is the most common zeolite in the Hood Road quarry.

Chabazite appears to have grown contemporaneously with the first phase of calcite, and also levyne when the latter occurs. Many of the chabazite crystals growing directly on the lava have an iridescent internal reflection which derives from the augite phenocrysts on the rock itself.

Levyne occurs either as masses of platy crystals with bevelled edges which commonly completely fill cavities or are intergrown with chabazite. This mineral is rare in the lava at this locality.

Gismondine has two forms – clear and chalky. Most commonly it occurs as chalky white aggregates, forming coarsely lamellar 'rosette-like' clusters, often encrusting chabazite or calcite (Fig. 2). Tiny crystals of chabazite have also been observed within the gismondine crystals. The calcite was



Fig. 2 Photo of chalky gismondine showing the typical aggregates of lamellar rosette-like clusters growing atop chabazite and encrusting calcite. Later "saddle"-shaped calcite appears as the smaller, clearer globule-like shapes.

frequently been dissolved leaving a hollow centre to the gismondine encrustations. "Saddle"-shaped calcite sometimes grows atop of the gismondine. The chalky variety is soft and powdery to touch and may have been weathered. However, none of the other minerals seem to exhibit this physical appearance. This is corroborated by the findings of Walker (1962).

Thomsonite appears to have two generations – the first is a spherular form, while the second is helical crystals growing on the spherules. Like gismondine, thomsonite encrusts either chabazite or calcite crystals and sometimes remains as hollow encrustations after dissolution of the calcite.

Tiny scalenohedral calcite sometimes grows atop the thomsonite.

Dykes intruding the lava contain considerably fewer types of zeolites than the lava and also have a different zeolite assemblage. Vesicles in the dyke are lined with an iron-rich saponite-type mineral which is dark green when fresh and oxidises rapidly when exposed to the air. Zeolites crystallise on the saponite rim. The major zeolite constituent is levyne with a thin platy habit. The levyne plates are overgrown with erionite-offretite crystals.

PROPERTIES OF THE TWO VARIETIES OF GISMONDINE

X-ray powder diffraction patterns of the clear and chalky varieties of gismondine were indistinguishable. Infra-red spectra, obtained on a Biorad FTS7, were nearly identical but the clear gismondine variety has consistently lower percentage transmittance (Fig. 3). Electron microprobe analyses showed that the chalky variety contained slightly more Al and had lower alkalis (Fig. 4)

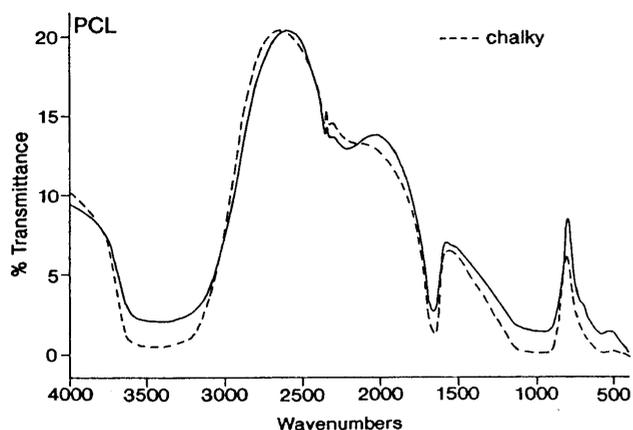


Fig. 3 FT spectra for clear (solid line) and chalky (dotted line) gismondine.

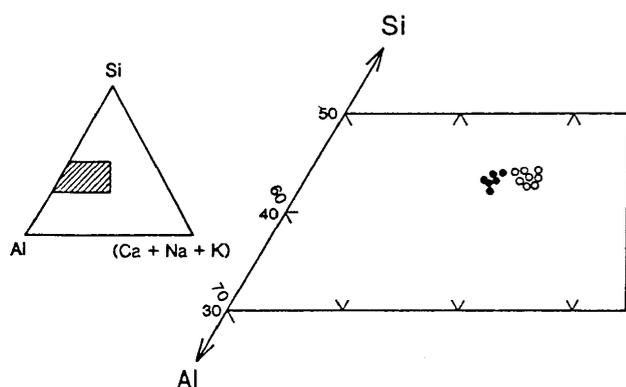


Fig. 4 Compositions of gismondines from Aranga summarised on ternary diagram. Open circles and closed circles represent clear and chalky varieties respectively.

although both were low K and Na varieties. Most of the gismondines analysed had no detectable K and the molecular $\text{Ca}/(\text{Ca}+\text{K}+\text{Na})$ ratio for both the clear and chalky gismondines ranged from 0.85 to 0.90. The weight loss curves of the two gismondine varieties showed the chalky sample had more low temperature water (54%) than the clear variety (47%) (Fig. 5). Significant differences were detected in the thermal properties of the two gismondine varieties. Although the DTA spectra of the two varieties, obtained on a Polymer STA 1500, were very similar with 2 endotherms, one at 90–100°C and the other major endotherm at 175°C, there was a difference in the position of the first endotherm (Fig. 5) with the chalky sample having its endotherm at 94° while the clear sample had its endotherm slightly higher at 100°. It is also notable that while the Aranga gismondine DTA curves are similar to that for the gismondine sample from Montalto di Castro, Italy (Gottardi & Galli 1985), the Aranga gismondines' endo-therms

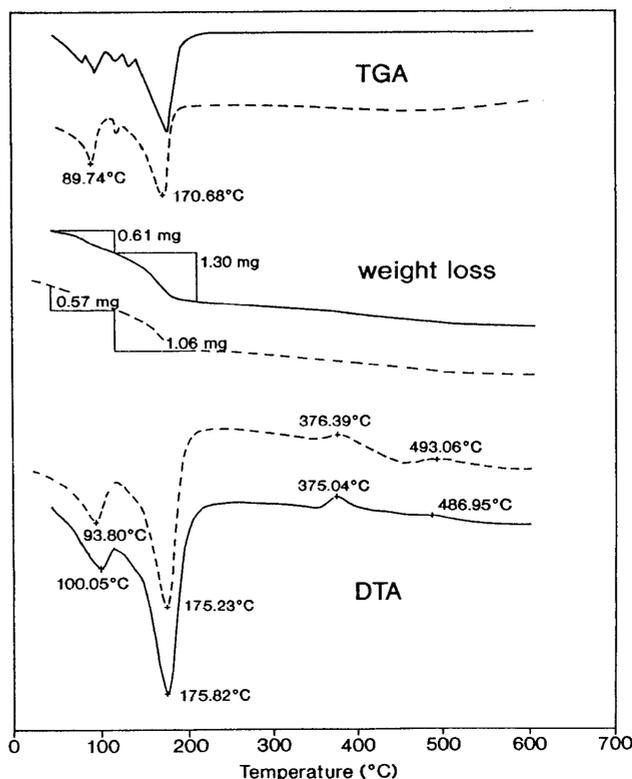


Fig. 5 Thermal data for clear (solid line) and chalky (dotted line) gismondine.

are all lower by about 40° than the Italian gismondine sample.

DISCUSSION

The Aranga zeolite assemblages and associated volcanic rocks are similar to those associated with the occurrence of gismondine in the Antrim lavas of Ireland (Walker 1962). Whereas, in the Aranga occurrences, the position of gismondine in the paragenetic sequence of zeolites is also similar with gismondine crystallising after chabazite. The relationship between thomsonite and gismondine, and levyne and gismondine, is uncertain as these minerals have not been found in the same druse.

The association of zeolitisation and alteration of plagioclase with the lava suggests that the dykes were the source of heat for the hydrothermal solutions. Judging from the abundance of calcite these were probably local groundwaters. Devitrification of glass liberated the alkalis necessary for the crystallisation of the zeolites. Kristmannsdóttir & Tomassón (1978), who studied zeolite zones in geothermal areas in Icelandic basalt sequences, have shown that the zeolite zones containing chabazite and thomsonite are the shallowest and represent temperatures of less than 80 °C.

The relationship between the clear and the chalky gismondine is unclear. The two varieties never appear together and one does not seem to alter to the other, although the degree of hydration of the mineral is clearly a factor. The discrepancy between the DTA data for the Aranga gismondines and other published data for the mineral is also problematical and will only be resolved by comparative work on gismondine samples of varying compositions from other localities.

ACKNOWLEDGEMENTS

I would especially like to thank Philippa Black for encouragement and help with the writing of this manuscript. Also thanks to Brent Alloway, Peter Ballance and Kerry Rodgers for commenting on drafts of the manuscript, and to Louise Cotterall for drafting the figures.

REFERENCES

- BAKER C. K. & BLACK P. M. (1980), Assimilation and metamorphism at a basalt-limestone contact, Tokatoka, New Zealand. *Mineralogical Magazine*, **43**, 797-807.
- GOTTARDI G. & GALLI E. (1985), *Natural Zeolites (Minerals and Rocks 18)*, Springer Verlag, Berlin, Heidelberg, 409p.
- KRISTMANNSDÓTTIR H. & TOMASSÓN J. (1978), Zeolite zones in geothermal areas in Iceland, In: Sand L. B. & Mumpton F. A. eds., *Natural Zeolites Occurrence, Properties and Use* (1st Edition), 277-294, Pergamon Press, Oxford.
- RAILTON G. L. & WATTERS W. A. (1990), Minerals of New Zealand. *New Zealand Geological Survey Bulletin*, **104**, 89p.
- WALKER G. P. L. (1962), Low-potash gismondine from Ireland and Iceland. *Mineralogical Magazine*, **33**, 173-199.
- WRIGHT A. C. (1980), Volcanic geology of the Waipoua area, Northland, New Zealand. *New Zealand Journal of Geology and Geophysics*, **23**, 83-91.