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To cite this article: J. W. Cole (1978) Tectonic setting of Mayor Island volcano (Note), New Zealand Journal of Geology and Geophysics, 21:5, 645-647, DOI: [10.1080/00288306.1978.10424091](https://doi.org/10.1080/00288306.1978.10424091)

To link to this article: <http://dx.doi.org/10.1080/00288306.1978.10424091>



Published online: 12 Jan 2012.



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## Tectonic setting of Mayor Island volcano (Note)

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### ABSTRACT

Mayor Island, a peralkaline volcano in the northwestern Bay of Plenty, is chemically different from all other Cenozoic lavas in the North Island. It is of similar pantelleritic composition to the islands of Pantelleria and Socorro and the silicic volcanoes of the Main Ethiopian Rift, each of which is associated with a tensional environment. Mayor Island is near the edge of the continental shelf, within a southeastwards extension of the Ngatoro Basin, a steep sided graben structure which is regarded as an extensional island-arc basin. The tectonic setting of the island is thus comparable to the other known pantelleritic volcanoes.

### INTRODUCTION

Mayor Island (37°17' S; 176°15' E) is an isolated volcano 26 km offshore in the northwestern Bay of Plenty, sited close to the edge of the continental shelf (Fig. 1). There have been many accounts of the island's morphology, chronology, and petrography and these have been summarised by Brothers (1957). Geochemistry has been described by Ewart (1968). The island has always been of particular interest in that it is petrographically and chemically quite unlike any of the other Cenozoic volcanics of the North Island, New Zealand. Marshall (1936, p. 344) recorded that the lavas were alkaline and differed from those of the Rotorua-Taupo region, but that "no suggestion is offered as to the cause of the concentration of the alkaline features in the acid magma in this small localised area". Ewart (1968, p. 136) regarded the lavas as the "end product of extreme crystal fractionation", but again does not account for their occurrence in a predominantly 'calc-alkaline' region.

Volcanism is very young; wood found in a breccia of the main cone series has a  $^{14}\text{C}$  age of  $8390 \pm 135$  years B.P. (Grant-Taylor & Rafter 1962) and wood from later tephra a  $^{14}\text{C}$  age of  $6600 \pm 100$  (Buck 1976). Any explanation for the peralkaline volcanism must therefore equate with the present-day tectonic situation.

### TECTONIC SITUATION OF PERALKALINE VOLCANISM ELSEWHERE

By definition, peralkaline rocks have a molecular excess of  $(\text{Na}_2\text{O} + \text{K}_2\text{O})$  over  $\text{Al}_2\text{O}_3$  (Macdonald 1974) and are usually associated with crustal tensional conditions (Le Bas 1971; Macdonald 1974). They can be divided (Lacroix 1927; Noble 1968) into comenditic lavas ( $<12.5\%$  normative femic minerals) and pantelleritic lava ( $>12.5\%$  normative femic minerals). Comenditic lavas are associated particularly with oceanic suites (Baker 1974), occurring on Easter Island, Pitcairn, Samoa, etc. Pantellerites are more typically associated with 'rift' environments, e.g., Pantelleria (Villari 1974) and the Main Ethiopian Rift (Gibson 1972; 1974). In

the Ethiopian Rift the peralkaline centres are associated with the Wonji Fault Belt (Mohr 1960), an axial zone of intense faulting in which N-S extensional faults occur in a series of en echelon zones oblique to the rift margin. Each centre (e.g., Fantale, Gariboldi, Boseti Guda) is associated with a different en echelon fault zone, and between each centre basic rocks erupted from fissures predominate.

An apparent anomaly to the broad distinction between occurrences of comendites and pantellerites is Socorro Island (18°6' N; 111°0' W) an oceanic volcano of pantelleritic composition (Baker 1974). Bryan (1966), however, noted that the island is located at the intersection of the E-W Clarion Fracture Zone and a N-S trending ridge, and that later volcanic activity is related to N-S trending rifts crossing on the island. This rifting is probably related to the complex tectonic situation resulting from the break-up of the Farallon plate into smaller plates and/or the interaction of the East Pacific Rise with the North American continent (Anderson & Sclater 1972). The siting is thus not very different to Pantelleria.

### COMPARISON BETWEEN MAYOR ISLAND AND OTHER PANTELLERITIC VOLCANOES

Mayor Island lavas are all pantelleritic (Ewart 1968), and although the island is smaller (diameter approx. 4 km), it is morphologically similar to Pantelleria (Villari 1974); Fantale and Gariboldi, Ethiopia (Gibson 1974; Cole 1969); and Socorro (Bryan 1966; 1970). At each volcano, a main cone has been built up, and subsequently the top has collapsed to form a caldera. Accompanying or following this collapse ignimbrites were erupted from Pantelleria, Fantale, and Gariboldi, and "glowing avalanches" from Mayor Island (Buck 1976). Younger domes, accompanied by tephra eruption developed within each caldera structure. The final phase at Pantelleria, Fantale, and Gariboldi was the eruption of alkali basalts from vents aligned along fissures crossing the caldera. This phase is not, however, present at Mayor Island.

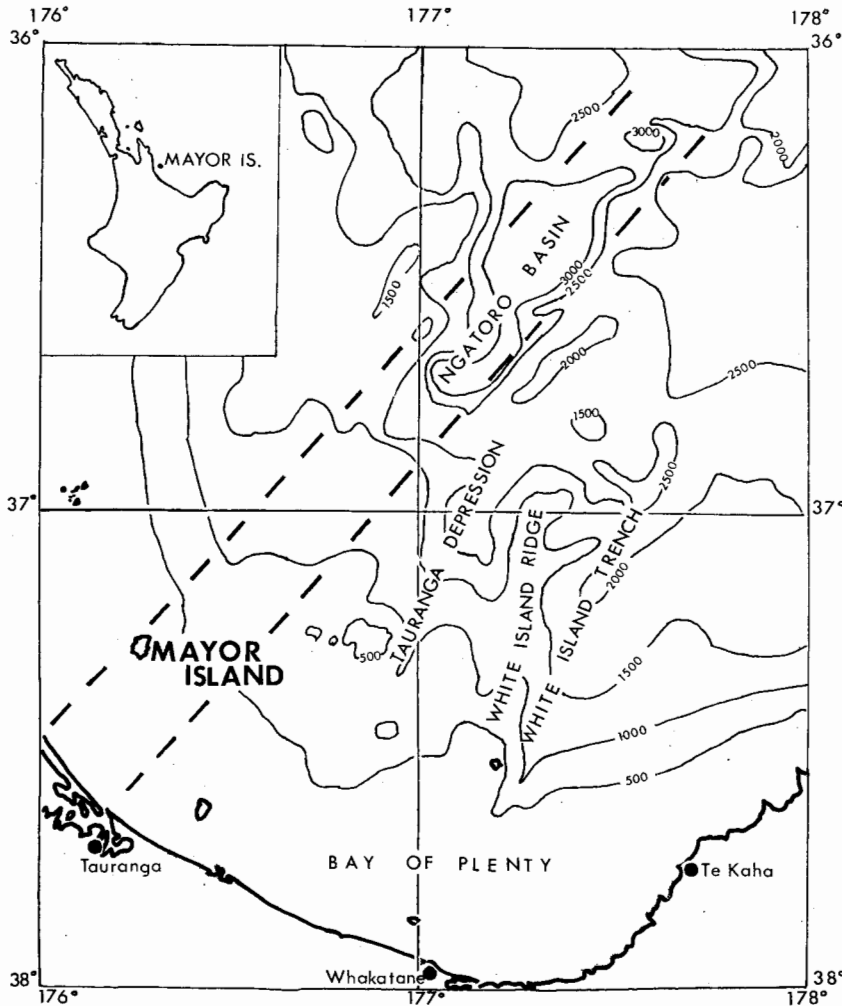


FIG. 1—Location of Mayor Island, and its relationship to the Ngatoro Basin. Bathymetry shown in metres.

## DISCUSSION

Pantelleria, Fantale, and Garibaldi are all sited within known rift valley structures and 'rifts' cross Socorro; hence, it is logical to see whether the same is true of Mayor Island. No obvious faults are evident from the bathymetry immediately surrounding the island, but with the high sedimentation rate around the island such features could be obscured. Directly northeast of Mayor Island is the Ngatoro Basin (Fig. 1), the eastern and western sides of which are steep sided (Carter 1976). Seismic profiles (Gulf Research and Development Co 1972) indicate that it is a graben structure. The Basin is considered to represent a southward continuation of the Lau and Havre Basins, which Karig (1970) and Hawkins (1974) regard as an extensional inter-arc basin.

If the trend of the Ngatoro Basin is projected south-eastwards on to the continental shelf, Mayor Island

would be sited within the graben structure, close to the western boundary, and near the edge of the continental shelf.

A further southeastwards extension of this structure would intersect the Bay of Plenty coast at Tauranga (Fig. 1). It may be significant that this area appears to be subsiding (Schofield 1968), whereas at Maketu and Waihi the coastline appears to be stable (J. G. Gibbs pers comm).

## CONCLUSIONS

It is thus likely that Mayor Island is sited within the southeastwards extension of the Ngatoro Basin, and is thus within a young inter-arc basin. This is a tensional environment and the tectonic setting is thus similar to Pantelleria, the Main Ethiopia Rift and probably Socorro.

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