Tholeiitic magmatism in the Belingwe greenstone belt

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Introduction

The Belingwe greenstone belt in Southern Zimbabwe provides one of the best preserved Archaean volcanic suites in the world. The komatiites of the Reliance formation, at the base of the succession, are well studied. Work on the overlying, basaltic Zeederbergs formation has revealed that there are two distinct lava types, which has implications for the generation of the whole succession

Sampling and analysis

A large amount of geochemical data already exists from the ultramafic and mafic rocks of the Reliance formation, but little from the overlying, dominantly tholeiitic Zeederbergs formation. Three sections through this formation were sampled, and the main section, in the Ngezi river, was also mapped in detail. Samples were analysed by XRF for major and trace elements, and five samples have been analysed for *REE* using the Edinburgh Ion Microprobe on flash fused glass beads.

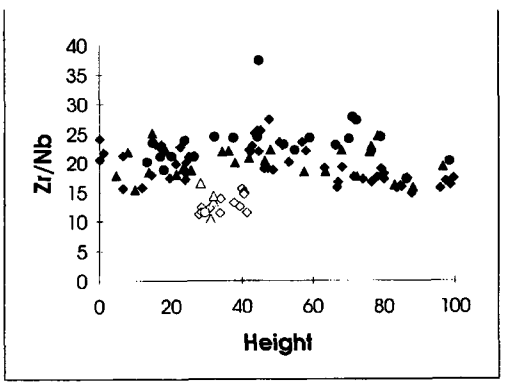

Fig.1 Plot of Zr/Nb vs. normalised stratigraphic height for the three different sections. Filled symbols = Type I lavas, Open symbols = Type II lavas. Diamonds = Section 1 (Ngezi River), Triangles = Section 2, Circles = Section 3.

Results

The Zeederbergs formation in the Ngezi River is approximately 3km thick. It is dominated by pillowed and, less commonly, massive lava flows, with some intercalated tuffs, breccias and hyaloclastites. The pillowed flows often contain amygdales, and the tuffs show many clear sedimentary structures associated with submarine deposition. The entire succession appears to have been erupted under water. The majority of the lavas are basalt to basaltic andesite in composition (49-60% SiO_2, 5–12% MgO).

Examination of the Zr/Nb ratio with stratigraphic height in the Ngezi River section showed that there was a sudden drop from $\approx$20 to $\approx$13 for several hundred metres about a third of the way up section. Comparison with the other sections showed that this zone of lower Zr/Nb also existed in the same position (although possibly thinner) in both of them (Fig.1). These low Zr/Nb lavas are also significantly different in many other chemical characteristics, and two distinct lava types, Type I and Type II, can be defined. A summary of the differences between these two types is shown in Table 1. It is important to note that no systematic difference in either SiO_2 or MgO contents is seen, except that possibly the Type II lavas are limited to the less evolved end of the spectrum (SiO_2 < 56%).

Discussion

The appearance of the horizon of Type II lavas at approximately the same stratigraphic position in three different sections around the belt suggests that it is a continuous layer. This information, combined with the field characteristics of the lavas and the field relations of the Ngezi group as a whole requires that the Zeederbergs formation was erupted underwater onto a flat, continental surface.

The Type I lavas are fairly unremarkable tholeiitic basalts, which are moderately depleted in incompatible elements. They would seem to be lower degree melts of the same source material as the more ultramafic rocks of the Reliance

TABLE 1. Summary of differences between Type I and Type II lavas within the Zeederbergs formation

Type I	Type II
Average Zr/Nb 20	Average Zr/Nb 12
Average Al_2O_3/TiO_2 22	Average Al_2O_3/TiO_2 8
Average CaO/Al_2O_3 0.7	Average CaO/Al_2O_3 1.2
Flat *REE* pattern at 10 × chondrite (La/Yb 1.4)	Strong *LREE* enrichment; La,Ce at 100 x chondrite, Yb at 10 x chondrite (La/Yb 7.6)
Richer in Sc, V than Type II	Higher FeO, P_2O_5 at given SiO_2
	Low Al_2O_3 contents (Av. 9%)
	Richer in Nb, Zr, Sr, Th, Pb, Cu, Cr, Ba than Type I

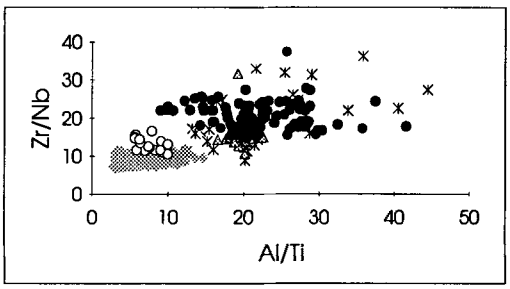

Fig. 2 Al_2O_3/TiO_2 vs. Zr/Nb for Belingwe and Icelandic lavas. Circles are Zeederbergs lavas, black = Type I, white = Type II, grey triangles = Reliance formation lavas. Light grey diamonds = Tertiary Icelandic basalts (off axis), crosses = Icelandic axial zone lavas (B.S. Hardarsson and J.G. Fitton, unpublished data).

formation, or possibly descendants of these rocks through AFC processes. The Type II lavas, however, are not easily derived from either the Reliance formation, or Type I lavas, by simple fractionation or AFC.

There are some parallels between the Type I/II distinction in the Zeederbergs formation and the axial/off-axial lavas in Iceland (see Fig.2), but the very low Al_2O_3 contents are not seen in Icelandic rocks. The enrichment in incompatible elements combined with the depletion in compatible elements would suggest that the source region of the Type II lavas had been depleted by a previous melting event, but contained some component of enriched material which dominated the incompatible element composition. This may be confirmed by Nd isotope work in progress.