3-D ^{40}Ar–^{39}Ar geochronology in the Paraná flood basalt province

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New ^{40}Ar–^{39}Ar ages have been obtained on borehole and surface samples from the Paraná continental flood basalt (CFB) province. Ages from lavas in the central (136.1 ± 0.9 Ma) and western (138.4 ± 1.3 to 133.5 ± 0.8 Ma) parts of the province, as well as dykes in Paraguay (137.4 ± 1.0 Ma, 138.4 ± 1.3 Ma) are amongst the oldest so far determined. These confirm the 138–127 Ma duration and NW to SE migration of magmatism indicated by early results and interpreted to reflect a combination of movement over the Tristan plume and extension across the Ponta Grossa dyke swarm (Turner *et al.* 1994). Thus the Paraná CFB had eruption rates similar to present day oceanic islands and was not responsible for the ~140 Ma Tithonian extinction. These results bring into question the notion that most CFB erupt in less than 1 m.y. and are intimately related to mass extinction events.

Results from borehole material provide a unique 3-dimensional geochronology of the lava pile (Fig. 1). In the CB borehole, in the thickest, north-central part of the lava pile, ages determined thus far range from 137.8 ± 1.0 Ma (1902 m), through 136.0 ± 3.5 Ma (1335 m) to 131.6 ± 2.6 Ma (648 m) with increasing stratigraphic height.

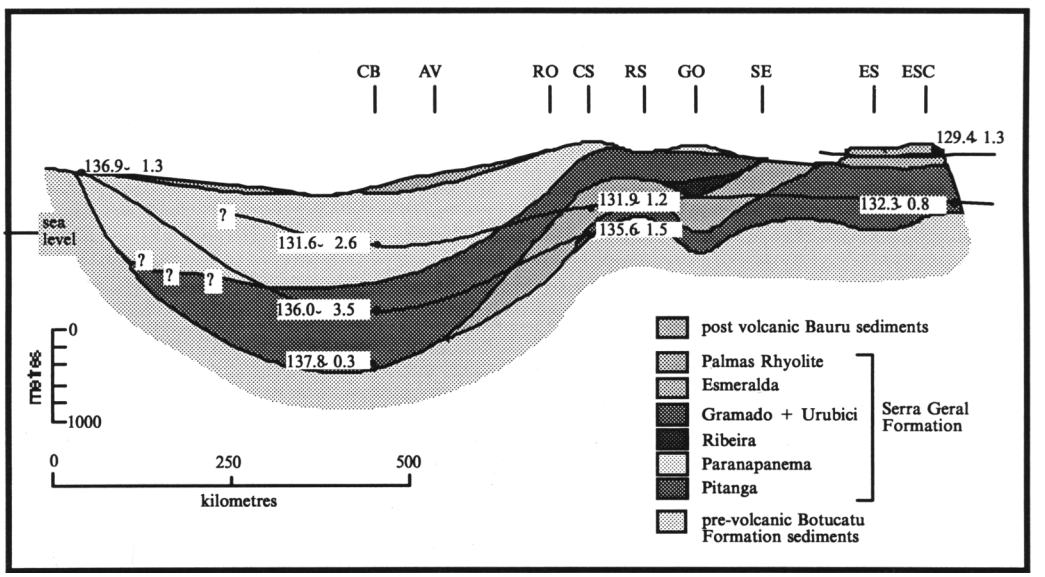

FIG. 1. A NW-SE section across the Paraná flood basalt province illustrating the chemically defined magma types together with ages from both borehole and surface samples. The heavy dashed lines join samples whose ages are within error (1σ). Note that these lines crosscut the chemical stratigraphy of Peate *et al* (1992). CB, AV, RO, CS, RS, GO, SE and ES are boreholes, ESC represents a composite of several road sections on the escarpment in the SE of the province.

Further south, in the CS borehole, the basal sample (900 m) has an age of 135.6 ± 1.5 Ma whereas a sample at 687 m is 131.9 ± 1.2 Ma. The data obtained suggest that ~50% of the lavas in the NW parts of the province were erupted between 138 and 136 Ma, followed by further magmatism at approximately 132 Ma, whereas towards the south early magmatism at about 136 Ma erupted proportionally less magma, with the bulk of the lavas being 132 Ma. On the Serra Geral escarpment, further SE, magmatism spanned 133-128 Ma (Renne *et al.*, 1992; Turner *et al.* 1994). Thus, although the lava pile is thinner (~1000 m) on the escarpment, the eruption rate of the later magmas (*c.* 132 Ma) appears to have increased as magmatism migrated towards the SE. This presumably reflects higher degrees of extension (ultimately $\beta \rightarrow \infty$) in the SE near the incipient South Atlantic margin at 133-128 Ma. In contrast, the degrees of extension in the NW at 138-135 Ma probably involved β values < 1.4.

Different geochemically defined magma types (Peate *et al.* 1992) erupted simultaneously in some areas, while others erupted at different times in different places. Thus, for example, low-Ti Gramado magmas erupted at 136 Ma in the central parts of the province, 132 Ma on the escarpment, where they are intercollated with the high-Ti Urubici lavas, and 127 Ma in Uruguay by which time Esmeralda magmas were erupting on the escarpment. In the northern parts of the province high-Ti Pitanga magmas were the first to erupt at 138 Ma and were followed by Paranapanema (intermediate Ti). In contrast, Gramado magmas preceded the Pitanga further to the SE. These observations demonstrate that in the Paraná chemically defined magma types cannot be regarded as chronostratigraphic units and they suggest that melting took place over a wide area beneath the province. Moreover, since it would appear that these irregularly distributed source regions were compositionally distinct, and decompression melting of the plume is not favoured at the low degrees of extension that accompanied the onset of magmatism in the NW, we infer that melting took place in a heterogeneous lithospheric mantle at the volatiles present solidus.

References

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