AN ESTIMATE OF THE DEGREE OF CRUSTAL EXTENSION AND THINNING ASSOCIATED WITH THE GUAPIARA LINEAMENT BASED ON AEROMAGNETIC MODELLING

F.J.F.Ferreira[1]
R.Monma[1]
C.A.G.Campanha[1]
V.L.Galli[1]

The Guapiara lineament is an important tectonic feature of the southeastern continental margin of Brazil that extends for about 600 km in aeromagnetic surveys NW-SE from the confluence of the Verde and Paraná rivers to the Iguape region on the coast of São Paulo State. This lineament represents a fissure zone 20 to 60 km wide, related to crustal bulging, that defines the northern limit of the Ponta Grossa Arch (FERREIRA et al., 1981) and was filled by diabase dikes.

In order to estimate the degree of crustal extension associated with the intrusion of diabase dikes in the Ribeira Valley (São Paulo), three profiles transverse to regional structure were constructed and modelled utilizing maps of the residual magnetic field at a scale of 1:100,000 of the DNPM/CPRM (1988). The aeromagnetic survey was carried out in 1978, in a N-S direction with a spacing between flightlines of 1000 m at an average height of 150 m. The average spacing of measurements was around 100 m and a grid of 250 m was used for automatic contouring.

The programme used for aeromagnetic modelling was based on TALWANI & HEIRTZLER (1964) and assumes that the dykes are vertical. Magnetic susceptibility variations were based on measurements carried out in the Paleomagnetic Laboratory of the Instituto Astronômico e Geofísico of the Universidade de São Paulo on 60 samples of dikes from the Ponta Grossa Arch. Values for K fell between 0.121×10^{-3} and 7.86×10^{-3} e.m.u., with an average of 3.8×10^{-3} e.m.u., while the values used in modelling varied between 0.75×10^{-3} and 4.05×10^{-3} e.m.u., with a concentration around 2.95×10^{-3} e.m.u.

Modelling was then worked out by trial and error using a system of dikes composed of a certain number of bodies with thicknesses, spacings and susceptibilities compatible with the parameters observed in the field and laboratory. In general, this procedure satisfactorily explained the observed aeromagnetic data. The degree of crustal extension along the studied profiles was estimated by subtracting the sum of the calculated thicknesses of the dikes from the total width. These results indicate crustal extension of 20.5%, 16.8% and 17.8%, for the three profiles with an average of 18.36%. These are considered as minimum values, since prior to the brittle stage which allowed injection of dikes, the crust in this region must have suffered a ductile process.

It is necessary to stress the possible introduction of different sources of error involved in modelling, such as the assumption of a constant height in data acquisition (150 m); use of contour maps rather than profiles for which the density of information is higher (100 m); variations of magnetic susceptibility and thickness with depth; lack of magnetic

[1] DGRM, Instituto de Pesquisas Tecnológicas, Caixa Postal 7141, 01051 São Paulo, SP, Brasil.

profiles at ground level that would allow better resolution in the calculations of surface thickness of dikes; presence of other magnetic bodies below the surface (laccoliths, sills); reversed polarities and other factors.

Gravity modelling based on TALWANI & HEIRTZLER (op. cit.) also was carried out using data from the gravimetry chart of the State of São Paulo (GALLI et al., 1987) based on profiles approximately 100 km long between Adrianópolis and Capão Bonito, with an average spacing of 3 km between stations. For the elaboration of the final gravimetric model, several alternative models were tested assuming in all cases a mantle density of 3.3 g/cm^3, an average crustal density of 2.85 g/cm^2 and an original crustal thickness of 35 km. The first model was elaborated to explain the high gravimetric value of the profile (17 mgal) as due to an uplift of the mantle of approximately 12 km under a dike swarm, implying a crustal thinning of 34.3%. This value was considered excessive in spite of a good fit between calculated and observed data.

In the second model, the crust-mantle interface was considered as smooth and a crustal slice with dikes was introduced, whose width of 38 km at the surface was based on aeromagnetometric charts. Tests of density contrast of 0.02 g/cm^3 and 0.03 g/cm^3 were carried out between crust with diabase dikes and host-rock without dikes. These alternative models were unable to explain the observed anomaly satisfactorily.

Thus, a third model combining aspects of the previous alternatives was elaborated in which the data are best explained assuming a maximum uplift of 5 km for the mantle (crustal thinning of 14.28%) associated with a 30 km-thick crustal slice with dikes having a density contrast of 0.02 g/cm^3.

Finally, considering average densities for mafic dikes (2.97 g/cm^3), crust (2.85 g/cm^3), and the crustal slice penetrated by dikes (2.87 g/cm^3)the volume percentage of dikes intruding the crust was calculated as 17% of the crustal slice, as follows:

$2.97x + 2.85\,(1-x) = 2.87$, where $x = 0.17$ or 17%.

REFERENCES

FERREIRA, F.J.F.; MORAES, R.A.V.; FERRARI, M.P.; VIANNA, R.B. (1981) Contribuição ao estudo do alinhamento estrutural de Guapiara. In: SIMPÓSIO REGIONAL DE GEOLOGIA, 3., Curitiba, 1981. **Atas**. Curitiba, SBG. v.1, p.26-240.

GALLI, V.L.; BLITZKOW, D.; SÁ, N.C. (1987) Carta gravimétrica do Estado de São Paulo, São Paulo. Convênio IPT/SCT-Pró-Minério (Relatório IPT 25645).

TALWANI, R. & HEIRTZLER, J.R. (1964) Computation of magnetic anomalies caused by two-dimensional structure of arbitrary shape. In: Computers in the mineral industries. Stanford, University Publications. p.464-480 (Geological Sciences, 9).