New mapping of kilometric anisotropies over the granulitic continental crust of Madagascar: melt - fluid migration and associated economic implications

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The new survey in Madagascar was an opportunity to collect novel geological information such as aeromagnetic and spectrometric data (Project of the Governorship of the Mineral Resources "PGRM" carried out by the Madagascan Ministry for Energy and Mines with assistance of the International Development Association, World Bank). We used these data, combined with field mapping, satellite images, gravimetric, and topographic data to map foliation trends and lithological bodies. We especially emphasize strain evolution and refine geometry of previously distinguished ductile shear zones and identify new ones (5-15 km x > 350 km). These transpressive shear zones are of Neoproterozoic-Cambrian age, and some of them are rooted in the mantle. Aerial gamma-ray spectrometry shows variation of energy level associated with K, U and Th variable concentrations. Comparing similar lithologies, Th is concentrated inside the shear zones with high lateral gradient (< 2 km). Th is a compatible element which concentrates into the melt therefore Th spectrometric signal marks melt migration in the shear zone. The magnetic field is cause by magnetic mineral in the rocks. Low and high magnetic anomalies measured in nanotesla are correlated with the entire width of the shear zones. The aeromagnetic highest values are restricted in Zazafotsy shear zone and the aeromagnetic lowest values are restricted in Beraketa shear zone. Low anomalies are associated with graphite mineralisations and disappearance of iron bearing minerals, high anomalies are associated with magnetite mineralization which reach 15 modal percent of the rock. Moreover, oxides mark melting, as biotite breakdown produces K-feldspar melt and oxide (magnetite – ilmenite). All these data are coherent with melt and fluid migration localized into the shear zone. The paths of melt and fluid are also underlined by mineralization of economic interest such as gold and corundum. Primary diffuse gold mineralization is associated with syenites and granites emplaced in the crust. Gold is remobilized and concentrated into shear zones more than 60 km from their sources. Occurrences of granulite facies metamorphic corundum exist in aluminous bodies where metasomatism occurs (Rakotondrazafy et al., 2008). The corundum primary mineralization occurs inside 3 types of kilometric anisotropies where mass transfer is localized into: i) minor or major shear zones ii) contact between kilometric lithological bodies iii) hinge lines of kilometric folds. Integrating these data, we suggest that melt and associated fluid migration are controlled by kilometric shear zones (5-15 km x > 350 km). From these lithospheric anisotropy advections made possible by a network of various smaller kilometric anisotropies. We propose that this efficient chanelling produces local advection of melt and temperature. This mechanism coupled with conduction in between these close channels could explain homogeneous granulitic temperature over huge areas.

Rakotondrazafy, A. F. M., G. Giuliani, D. Ohnenstetter, A. E. Fallick, S. Rakotosamizanany, A. Andriamamonjy, T. Ralantoarison, M. Razanatseheno, Y. Offant, V. Garnier, H. Maluski, C. Dunaigre, D. Schwarz and V. Ratrimo (2008). Gem corundum deposits of Madagascar: A review. Ore Geology Reviews, 34, 134-154.

PGRM: http://www2.gaf.de/BPGRM/