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Studies in Rockmagnetism and Paleomagnetism

Report by *J.-J. Wagner**) and *I.G. Hedley**)

The Petrophysics laboratory in the Department of Mineralogy of Geneva University has worked on the following topics within the scope of the Geodynamics project:

- a) Contribution to the magnetic modelling of the oceanic crust through the study of ophiolites which are considered to be ancient oceanic crust.
- b) Studies of the emplacement and deformation of continental and oceanic igneous rocks.
- c) Paleomagnetism of quaternary lake and marine sediments.

a) MAGNETIC INVESTIGATIONS OF OPHIOLITES

Work has been carried out in the western Alps and in the eastern Mediterranean.

1. Ophiolite complexes of the Montgenèvre (French/Italian Alps) and Arosa (Swiss Alps).
2. Ophiolite complexes of the Hatay (Turkey) and Troodos (Cyprus).

The main differences in the field between the eastern Mediterranean and the western alpine ophiolites are that the latter do not exhibit a well developed sheeted dike complex and have a rather thin cumulate sequence. As these ophiolites may have been formed in different oceanic settings, we suggest that the above differences could be related to the spreading rate, the alpine one being the faster.

The magnetic signatures of the two ophiolite areas are also quite different. The following table gives the ranges of values of the natural remanent magnetization (NRM) and of the bulk susceptibility.

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Area rock unit.	western Alps		eastern Mediterranean	
	NRM (G)	SUSCEPT (G/Oe)	NRM (G)	SUSCEPT (G/Oe)
Pillow lavas	10^{-7} - 10^{-3}	10^{-5} - 10^{-3}	10^{-4} - 10^{-1}	10^{-3} - 10^{-2}
dikes	10^{-7} - 10^{-3}	10^{-5} - 10^{-3}	10^{-4} - 10^{-2}	10^{-5} - 10^{-2}
gabbros	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-5} - 10^{-2}	10^{-5} - 10^{-2}

The magnetic parameters are much lower for the western Alps. This could be related to the effect of the alpine regional metamorphism (pumpellyite-prehnite and pumpellyite-actinolite facies), but oceanic hydrothermal effects cannot be ruled out.

The different units of the ophiolites have been compared with actual oceanic crust and the following points should be noted:

1. If the low magnetization of the alpine ophiolites is a result of oceanic hydrothermal activity, the lack of magnetic lineations in some oceanic basins could be explained by using the magnetic model of the Montgenèvre ophiolite.
2. The gabbroic layer in off-ridge areas must contribute to the magnetic lineations (Hatay ophiolite model).

b) MAGNETIC FABRIC OF IGNEOUS ROCKS

In order to study the mode of emplacement and possible later tectonic deformation, the anisotropy of initial magnetic susceptibility (AIMS) has been measured on granites (western Turkey), on sheeted dike complexes (Hatay and Troodos) and on ophiolitic gabbros (Montgenèvre). As these investigations are still in progress, only the preliminary results are listed:

1. The study of granitic plutons (Kozak, Turkey) shows that the orientation of the AIMS ellipsoid is in agreement with a structural development during diapiric emplacement.
2. The study of dikes from sheeted complexes seems to indicate that the principal AIMS ellipsoid axes are not necessarily oriented as predicted by a simple flow model. In such a model the maximum and the intermediate axis are in the flow plane; the direction of the maximum being the flow direction. The minimum axis is perpendicular to the flow plane. The discrepancies noted in the dikes maybe related to injection under stress and also to further intrusion by a later series of dikes. The detailed investigation of the Troodos dike complex has been undertaken in collaboration with the laboratory of petrology, University of Nancy, France.
3. In a study of intra-oceanic crust deformation, the AIMS of progressively deformed gabbros shows that the fabric corresponds to deformation by simple shear.

c) PALEOMAGNETISM OF SEDIMENTS

1. A paleomagnetic study of non-consolidated quaternary sediments from Lakes Geneva and Morat (in collaboration with the Department of Geophysics, Edinburgh University) has revealed the recent geomagnetic declination variations for this region.

2. Deep-sea sediment cores from the Sicilo-Tunisian Strait have also been investigated (in collaboration with the Marine Geodynamic centre at Villefrance-sur-mer, France, GESIT 73). The most interesting discovery was the presence of greigite, (Fe_3S_4) a rare magnetic iron sulphide.

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