Geophysical Research Abstracts, Vol. 7, 07350, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07350

The Chenaillet Ophiolite: a fossil Oceanic Core Complex?

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The Chenaillet Ophiolite in the Franco-Italian Alps represents a well-preserved ocean-floor sequence that was not affected by later Alpine metamorphism and was only weakly deformed during its emplacement in the Alpine nappe stack. Previous authors interpreted the voluminous pillow lavas showing a MORB signature and overlying gabbros and sepentinized peridotites as an atypical oceanic crust. Our observations show that this atypical oceanic crust preserves an oceanic detachment fault that can be mapped over a surface of about 16 km^2 capping exhumed mantle and gabbros onto which clastic sediments have been deposited. The massive basaltic flows, pillows and pillow breccias were emplaced onto the exhumed detachment surface during syn-magmatic normal faulting. These high-angle faults may have acted as feeder channels for the extrusive volcanic rocks overlying the detachment fault. In the following, we summarize the pertinent observations documenting the tectono-magmatic- relationships related to detachment faulting and their relation to sediments and tectono-sedimentary breccias, and discuss the post-detachment evolution marked by syn-tectonic emplacement of volcanic rocks.

The major new observation in the Chenaillet Ophiolite is the discovery of a detachment fault, capping the serpentinized peridotites and gabbros. In sections across the detachment within the footwall, syn-tectonic gabbros and serpentinized peridotites grade over some tens of meters into cataclasites that are capped by fault gouges.

Petro-structural investigations of the fault rocks reveal a syn-tectonic retrograde metamorphic evolution in the gabbros grading from syn-magmatic to seafloor conditions. Clasts of dolerite within the fault zone support the idea that detachment faulting was accompanied by magmatic activity. The presence of a hydrothermal system is indicated by strong mineralogical and chemical modifications observed within the fault zone.

Gabbro and serpentinized peridotite clasts occur in turbidites and tectono-sedimentary breccias overlying directly the detachment fault. Not only does this support the pre-Alpine age of the detachment fault, but it also indicates that this fault had to be exhumed at the seafloor. This is also confirmed by the reworking of gouges and cataclasites in tectono-sedimentary breccias overlying directly the detachment fault.

Across the whole Chenaillet Ophiolite, the volcanic rocks directly overlie either directly the detachment fault or the sediments. In several places in the Chenaillet unit, N-S trending high-angle normal faults have been mapped. These faults truncate and displace the detachment fault leading to small domino-like structure. The basins, limited by the high-angle faults are some hundreds to some few kilometres wide and few tens to some hundreds of meters deep. Because these high-angle faults are cut by the basal Alpine thrust fault and are sealed locally by basalts and obliterated by volcanic structures, we interpret these high-angle faults as oceanic structures. These formed before or during an incipient emplacement of the basalts. The alignment of basaltic dykes parallel to the high-angle faults and their increasing abundance towards these faults as well as the occurrence of massive basalts aligned along the faults may demonstrate the importance of these faults serving as feeder channels for the overlying volcanic rocks.

In conclusion, our observations suggest that the Chenaillet Ophiolite represents an oceanic core complex. This is supported by the occurrence of a large-scale detachment fault capping mantle rocks and gabbros and its primary contact to sediments reworking the exhumed basement. Detachment faulting is followed by syn-magmatic normal faulting during the emplacement of up to 300 meters of pillow basalts covering the exhumed detachment fault. This observation is important, because it shows that core complexes may be buried under thick volcanic sequences suggesting that they are more frequent in oceanic crust as so far supposed.