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Internal lithospheric rotation at the initiation of rift-drift: an example of proto-transform era tectonics from the Vourinos Ophiolite, Greece

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The initial concept and recognition in outcrop of a "petrologic moho" was established within the Vourinos ophiolitic complex of northern Greece (Jackson et al 1974). Follow-up work documented the contact between mantle tectonite and an ultramafic-mafic cumulate suite as one of an intrusional topography (Rassios 1981; Harkins et al 1980). The orientation of the petrologic moho and that of stratotectonic "upping" (based on magmatic layering and fractionation patterns) was observed to be at nearly a 90° rotation to that of the dominant lithospheric mantle -> magmatic -> oceanic sedimentary profile. While early research by the aforementioned investigators documented ductile and magmatic structural fabrics in great detail, the block rotation of the petrologic moho unit was assumed to be via a non-exposed Tertiary (?) brittle fault system. Such a fault system was not observed even during detailed explorationist investigation of the area during the 1980's and 1990's.

A synthesis of this early research within a modern framework of ductile lithospheric deformation reveals a fabric continuity that suggests this rotation occurred in near-ridge crest ductile conditions. Evidence towards this interpretation includes:

- Continuity of ductile mineral fabric (lineation and foliation) within the magmatic and restite tectonite peridotite within the petrologic moho section and between the petrologic moho section and regional mantle tectonite.
- Parallel orientation of sub solidus mineral enlargement between exposures within the neighboring sub-moho Aetoraches chrome mine and cumulus grains within the magmatic section of the petrologic moho area.

The mechanism of this rotational deformation could be ascribed to proto-transform era tectonism (Garya 2012) or complex deformation within transtensional-transpressional zones between transfer faults (Dewey et al 1998).

i) Several fragments of flaser gabbro were observed in the 1970's research in contact with the north west border of the magmatic section of the petrologic moho area. Today we recognize these could mark the trace of a high temperature (transform) fault;
ii) the cumulate rocks of the petrologic moho section trace magmatic evolution towards troctolite rather than gabbronorite as elsewhere at Vourinos (Rassios 1981). This, in a modern consensus framework, could also be a transform-related phenomenon;
iii) Vourinos is dominated by Cr-rich chromite and chrome ores. The only occurrence of Al-rich chrome ores within the Vourinos mantle section crop out within the nearby Kissavos locality. These Al-rich ores might be related to transform fault-related hydrous magmatic activity concurrent to sub-ridge crest crystallization.

The direct observation of oceanic transform fault systems is difficult: oceanic topographic maps of the "google earth" type show a thick network of such faults at ridge crests, directly implying the coexistence of active ridge crest lithospheric generation with transform fault initiation. Rare instances of transform faults have been documented from ophiolites (eg Troodos-Cyprus, Domokos-Greece) that cut through various lithospheric levels. We believe that at Vourinos, the rotation in ductile conditions of a block of approximately 3 km^3 is probably associated with this early ridge crest – transform era. If so, this shows the possible nature of the initiation of transforms at depths about 10km below the ridge crest system.

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