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Phengite eclogite from the Zermatt area (Swiss Western Alps)

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The Zermatt-Saas unit (ZSU) represents an HP/UHP ophiolite complex in the western Alps. Mid-Cretaceous to the Eocene subduction of the oceanic lithosphere under its southern margin produced eclogite from basaltic pillow lava, eclogite facies metagabbros, serpentinites and metasediments.

Rapidly retreating glaciers have exposed many km^2 of new outcrops in recent years in the Zermatt area. Mapping of these exposures in the area of the upper Theodul glacier (UTG) revealed an assemblage of rocks that includes eclogite, garnet-phengite schist, serpentinites and garnet-biotite schists and gneisses. The assemblage forms a separate unit, the UTG unit, that rests with a thrust contact on the ZSU metaophiolite. However, the tectonic connection of the unit with the ZSU is not yet clear.

The eclogites of the UTG unit are simple garnet omphacite rocks with modally abundant phengite (Si=3.4) and quartz. Minor and accessory minerals include paragonite, glaucophane, actinolite, epidote, zoisite, chlorite, rutile and titanite. This makes them distinctly different from eclogites elsewhere in the ZSU, which are quartz-free glaucophane-rich metapillow basalts containing also modally abundant Mg-chloritoid and paragonite.

The different mineral assemblage of the two types of eclogite is also reflected by the major element composition of the rocks. The eclogites of the UTG unit have 46-50 wt.% SiO_2 and differ from the eclogitic pillow basalts with $SiO_2 > 50$ wt.% and generally higher Na_2O. The compositional characteristics of the UTG eclogites suggests that the protoliths are continental within-plate-basalts, whereas the metapillow basalts of the ZSU represent mid-ocean ridge tholeiites.

Recent pressure-temperature estimates from phase equilibria in metabasaltic eclogites from the Zermatt area suggested peak conditions of 550-600˚C and 2.5-3.0 GPa, implying coesite stable conditions. In contrast, the UTG eclogites reveal metamorphic equilibration at 450-480˚C and 2.0-2.2 GPa using garnet-omphacite-phengite thermobarometry (Krogh Ravana and Terry, 2004).

From the distinctly different mineralogy and bulk rock composition of the UTG eclogites we conclude that the UTG unit is not part of the ZSU but represents a separate tectonic element with a continental affinity that has been subducted to moderate depth, however, along a gradient of 7.2˚C/km identical to the ZSU path. The eclogites reported here are the first eclogites outside the ZSU in the Zermatt area.