The role of rutile as a major carrier for the extended HFSE group (Nb, Ta, W, Sb, Sn and Mo) in high pressure rocks T. Zack[1], A. Kronz[2], S.F. Foley[3] and T. Rivers[4]; [1]Dept. of Geology, University of Maryland, College Park, MD 20742, USA (tzack@geol.umd.edu), [2]Geochemisches Institut, Universität Göttingen, Goldschmidtstr. 1, 37077 Göttingen, Germany, [3]Institut für Geologische Wissenschaften, Universität Greifswald, FL Jahnstrasse 17a, 17487 Greifswald, Germany, [4]Dept. of Earth Sciences, Memorial University, St.John's, Newfoundland A1B 3X5, Canada

Introduction: Rutile is an ubiquitous accessory phase in most orogenic eclogites and is also a common phase in many high grade metapelites, granulites and some blueschists. It has been the focus of considerable attention as the possible trigger phase for the release or retention of Nb and Ta in subduction zones due to the preferential incorporation of these highly charged elements in its crystal structure. However, it is less well known that rutile can also host considerable amounts of other high field strength elements (HFSE), such as Sn, Mo, Sb and W.

We have made a detailed study on rutile and coexisting phasesin samples from a well-studied eclogite locality, Trescolmen (Central Alps, Switzerland) [1]. These samples serve as an analogue for basaltic and pelitic rocks that have undergone subduction to mantle depth (ca. 650°C/2.0 GPa). Phases were analyzed by electron microprobe (Universität Göttingen) and laser ablation-ICP-MS (Memorial University).

Results: We found high concentrations of the following elements in rutile: Cr (140-16000 ppm), Zr (80-250 ppm), Nb (80-1800 ppm), Mo (2.3-7.0 ppm), Sn (30-130 ppm), Sb (4-80 ppm), Hf (3-11 ppm), Ta (3-110 ppm) and W (20-240 ppm). The large concentration ranges are due to compositional differences between samples; within sample variation is limited. Constant partition coefficients between phengite (the phase second-highest in HFSE) and rutile, especially for W and Nb, demonstrate a close approach to equilibrium during eclogite-facies conditions.

Mass balance calculations of HFSE in rutile and coexisting phases in eclogite show that rutile (modal abundance of about 1%), takes up >90% of the whole rock budget of Nb, Sb, Ta and W, and it is also an important carrier for Sn and Mo (30 to 40%). Although sulphides were analysed semi-quantitatively, it is concluded that they are not important carriers for the HFSE, based on good agreement of calculated whole rock composition with likely source rocks. Zircon (modal abundance of about 0.02%), contributes >90% of the whole rock budget of Zr and Hf.

Nb/Ta ratios in island arcs: Rutile/fluid partitioning experiments have shown that Nb and Ta can be fractionated from each other [2], with a lower Nb/Ta ratio in the fluid and a higher Nb/Ta ratio in the residuum compared to the starting composition. This could explain observations of low Nb/Ta ratios in low-K and calc-alkaline subduction-related lavas [3] and high Nb/Ta ratios in mantle eclogites thought to be relics of subducted crust [4]. However, the efficiency of this process has been questioned based on the low solubility of Nb and Ta in the fluid [2]. Evidence from this study casts further doubt on the importance of this process, as eclogites from Trescolmen, which experienced progressive dehydration during subduction, have Nb/Ta ratios in rutile that cluster tightly around a chondrite-like value of 15.9 (range 13.6 to 17.4 for analysed samples). Therefore the Nb/Ta fractionation has to be explained by processes other than dehydration of slab (like slab and/or 2nd stage mantle melting.

Sb in the slab component: Antimony has been found to be the most enriched HFSE in the slab component of island arc rocks [5]. Our findings exclude the breakdown of a particul ar phase, like sulphides, in the slab, since rutile is the dominant carrier for Sb, and rutile is assumed to be present during fluid loss in the slab. From this we conclude that the fluid itself must have the capacity to efficiently fractionate Sb from Nb.

Nb, Cr, Sn and Zr in provenance studies: Rutile in eclogites is characterized by higher Cr concentration at a given Nb concentration, and usually by a lower Sn concentration, compared to rutile in garnet mica schists. The Nb/Cr systematics can be explained by different source rock compositions, whereas the low Sn in eclogites can be explained by incorporation of this element in omphacite. All investigated rutiles from Trescolmen have rather uniform Zr contents, which can be explained by the buffering role of omnipresent zircon. We note that the few existing rutile analyses from high T granulites have higher Zr concentrations [6], pointing to the potential of tracking the provenance of detrital rutile (schists, eclogites, granulites) by means of their trace element patterns.

References: [1] Zack T. et al. (2001), submitted to *Chem. Geol.*, [2] Brenan J.M. et al. (1994) *EPSL* 128, 327-339, [3] Münker C. (1998) *Chem. Geol.* 144, 23-45, [4] Rudnick R.L. et al. (2000) *Science* 270, 625-627, [5] Noll P.D. et al. (1996) *GCA* 60, 587-611, [6] Fett A. (1995) PhD Universität Mainz, Germany.