THE EFFECT OF PRESSURE ON SULFIDE MELT DISTRIBUTION IN PARTIALLY MOLTEN SILICATE AGGREGATES: IMPLICATIONS TO CORE FORMATION SCENARIOS FOR TERRESTRIAL PLANETS. A. Holzheid[1], P. Balog[2,3] and D. C. Rubie[2], [1]Institut für Mineralogie, Universität Münster, Corrensstrasse 24, D-48149 Münster, Germany, holzheid@uni-muenster.de, [2]Bayerisches Geoinstitut, Universität Bayreuth, D-95447 Bayreuth, Germany, Dave.Rubie@uni-bayreuth.de, [3]Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany, P.Balog@fkf.mpg.de.

The dihedral angle of reduced metallic melts with upper mantle silicate minerals is larger than 60°, with the result that isolated metallic melt pockets are trapped at four-grain junctions at low melt fractions [1,2,3,4]. Small degrees of silicate partial melting do not significantly change the dihedral angle between metallic melts and olivine [5]. The high dihedral angle of metallic melts with upper mantle silicate minerals and the resulting inefficiency of percolative segregation have led to models for core segregation that require the production of large fractions of silicate partial melt: an end-member model being a global magma ocean (see [6] for a review of the various types of metal-silicate separation processes). A factor that may affect the efficiency of percolation is pressure. Shannon & Agee [7] determined a dihedral angle of ~108° of an Fe-Ni-S melt in an olivine-spinel-dominated matrix at upper mantle pressure conditions and a dihedral angle of ~71° of an Fe-Ni-S melt in a perovskite-dominated matrix at 25 GPa. Although this dihedral angle is >60° and therefore significant amounts of metallic liquid will be trapped in the solid silicate matrix, it is considerably less than the angles observed in mineral matrices at upper mantle pressure and temperature conditions. There are, however, only a few experimental data which bear on the effect of pressure on the interfacial energy of metallic melts or on the connectivity structure of coexisting immiscible silicate and metallic liquids in solid silicate matrices at upper and lower mantle pressure conditions. In the present study experiments were performed to systematically study the effect of pressure on the wetting behavior of sulfide melt in partially molten solid silicate matrices.

Experimental and analytical technique: In the first set of experiments multi anvil runs were performed within a pressure range of 5 to 11 GPa and at temperatures ranging from 1600 to 1850°C at the Bayerisches Geoinstitut. Run durations varied between 10 minutes and one day. Starting material consisted of a mixture of metal sulfide powder and finely ground San Carlos olivine single crystals coated with a basaltic silicate gel in volume proportions of 12.5 : 75 : 12.5 or corresponding weight proportions of 16.8 : 72.4 : 10.8 (metal sulfide : olivine crystals : primitive tholeiitic basalt), identical to the mixture used by [5]. The starting material was packed into a single crystal MgO capsule. Liquid metal sulfide and liquid basaltic silicate coexisted in a crystalline olivine matrix. The texture of the experimental charges was frozen-in by quenching. The sample pressure was released over a period of 4 to 12 hours depending on the target pressure of the experiment. Post experiment all run charges were mounted in epoxy, cut longitudinally through the center of the MgO capsule, and polished as microprobe sections. The interfacial angles between sulfide, basaltic silicate, and olivine were measured with image processing software from digital images acquired by backscattered electron detection on the secondary electron microscope JSM-840 A at the Universität Münster.

Results and Discussion: The figure comprises digital overview photomicrographs of two experimental charges. The top of the charges corresponds to the top of the images. The brightest phase within the MgO capsule is the iron sulfide, the darkest phase is the olivine, and the phase of intermediate brightness is the basaltic silicate melt. Experiment V-235 represents the starting assembly at 10 GPa and room temperature. Experiment V-236 (8 GPa, 1700°C, 15.3 hrs) illustrates the textural evolution with time at elevated pressure and temperature. Coarsening of the olivine grains can be observed in the experimental charge. The olivine grains have become rounded by solution of edges and precipitation on surfaces of low curvature. The iron sulfide is present as small metal sulfide blebs and as large metal sulfide pockets. The small metal sulfide blebs are mainly adhered to olivine grain faces but also present as discrete droplets. The largest sulfide melt pools are found at the lower part of the charge. The texture of the experimental charge was reproduced by other experiments at similar pressures and temperatures. As a preliminary result the sulfide melt distribution indicates possible interconnected liquid metal phases in a partially molten silicate matrix at higher pressures. Formation of the metallic cores in the Earth and other terrestrial bodies by percolation through the partially molten mantle of these bodies at greater pressures may be therefore possible, as postulated by [7,8]. However, the experimental observation has to be strengthen by additional experiments within an extended pressure range covering upper and lower mantle pressure conditions.

References: [1] Ballhaus C. and Ellis D. J. (1996) *Earth Planet. Sci. Lett.*, *143*, 137-145. [2] Minarik W. G. et al. (1996) *Science*, *272*, 530-532. [3] Shannon M. C. and Agee C. B. (1996) *GRL*, *23*, 2717-2720. [4] Gaetani G. A. and Grove T. L. (1996) *LPS XXVII*, 389-390. [5] Holzheid A. et al. (2000) *JGR*, *105 (B6)*, 13555-13567. [6] Stevenson D. J. (1990) in *Origin of the Earth*, 231-249. [7] Shannon M. C. and Agee C. B. (1998) *Science*, *280*, 1059-1061. [8] Walter M. J. et al. (2000) in *Origin of the Earth and Moon*, 235-289.