EFFECTS OF THE HYDROSPHERE ON THE EVOLUTION OF BASALTIC MAGMAS. M. E. Brandriss[1] and D. K. Bird[2], [1]Dept. of Geology, Smith College, College Lane, Northampton, MA, 01063, mbrandri@science.smith.edu, [2]Dept. of Geological & Environmental Sci., Stanford University, Stanford, CA, 94305–2115, bird@pangea.stanford.edu.

Overview: In layered gabbros of the Kap Edvard Holm Complex in East Greenland, gabbroic magmas were contaminated with water via the dehydration and partial assimilation of metabasaltic country rock xenoliths. This water was derived ultimately from the hydrosphere, which supplied meteoric water to the hydrothermal system that altered and hydrated the metabasalts under greenschist facies conditions. This alteration produced abundant hydrous secondary minerals such as chlorite, actinolite and epidote. Contamination of the gabbroic magma by this hydrous oxidized material dramatically altered phase relationships in the crystallizing pluton, producing an abrupt transition from layered olivine gabbro to massive semi-conformable layers of ultramafic rock and magnetite-rich oxide gabbro. The changes in mineral modes were not accompanied by significant changes in mineral compositions, implying that the main effect of contamination was simply to alter the relative stabilities of major cumulus phases [1]. The contamination of mafic magmas by dehydration of metabasaltic country rocks may thus alter liquid lines of descent, providing a mechanism by which hydrothermal solutions derived from seawater and/or meteoric water can fundamentally alter the evolution of basaltic magmas in the shallow crust.

Field Relations in the Study Area: The Kap Edvard Holm Complex consists mainly of layered olivine gabbros that intruded Precambrian gneisses and Tertiary greenschist-facies metabasalts during Eocene rifting prior to opening of the North Atlantic. Near the western part of the complex, the gabbros host large tabular xenoliths of metabasaltic country rock that were dehydrated and partially melted during stoping and heating [2]. As hydrous fluids and melts were expelled from the xenoliths, they percolated through and reacted with the host gabbroic cumulates, producing small, irregular, discordant replacive bodies of ultramafic rock and oxide gabbro clustered around xenolith margins. The ultramafic bodies represent zones in which plagioclase was resorbed by hydrous contaminated liquids that migrated through the partially solidified cumulates, the plagioclase having been destabilized relative to the mafic minerals as a result of the high concentrations of water. The oxide gabbros formed when these hydrous liquids crystallized within the cumulus pile.

Larger ultramafic and oxide gabbro bodies are present as semi-conformable sheets within the layered gabbro sequence, with oxide gabbro lying directly above ultramafic rock. These sheets, up to several meters thick and extending for hundreds of meters along strike, are locally discordant to layering in the overlying gabbros and must therefore have grown within an existing cumulus pile. Contacts with the layered gabbros appear to be replacive rather than intrusive, suggesting that the bodies grew metasomatically as the hydrous liquids infiltrated and reacted with the cumulates. The large ultramafic and oxide gabbro sheets are mineralogically and texturally similar to the small discordant bodies near xenoliths and are themselves in a zone in which xenoliths are abundant. It is therefore concluded that the large sheets likewise formed as a result of hydrous contamination of “ordinary” gabbroic magma.

Mineral compositions: A striking feature of the ultramafic and oxide gabbro bodies is that their constituent minerals are nearly identical in composition to those of the surrounding layered olivine gabbros. The Mg # of augite ranges from 0.74 to 0.78 and the Fo content of olivine ranges from 70 to 74, with no systematic differences among the various rock types. Plagioclase compositions are slightly more variable (mostly An_{54}–An_{68}), but the differences among rock types are small and the overlap in plagioclase compositions is extensive. The similarity of mineral compositions reflects derivation of all of the rock types from a single parental magma in which phase relations were shifted dramatically by the addition of small amounts of hydrous, oxidized contaminants. The resulting destabilization of plagioclase and stabilization of magnetite caused ultramafic and magnetite-rich rocks to form close together in the fractionation sequence. This is quite different from the behavior characteristic of tholeiitic magma systems, in which ultramafic cumulates are typically quite primitive (as observed commonly in ophiolites) and oxide-rich gabbros are substantially more evolved (e.g. Hole 735B on the Southwest Indian Ridge [3]). We therefore hypothesize that contamination of mafic magmas by hydrothermally altered basaltic crust can fundamentally alter liquid lines of descent, shifting them from tholeiitic trends of iron enrichment toward calc-alkaline trends of iron depletion and silica enrichment.

References: [1] Brandriss M.E. and Bird D.K. (1999) *J. Pet.*, *40*, in press. [2] Brandriss M.E. et al. (1996) *Am. J. Sci.*, *296*, 333—393. [3] Dick H.J.B. et al. (1991) *Proc. ODP*, *118*, 439—538.