SULFIDE UNSATURATED BASALTS FROM MID-OCEAN RIDGES AND OCEANIC PLATEAUS: IMPLICATIONS FOR PGE

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Mid-ocean ridge basalts (MORB) almost always erupt saturated with sulfide melt, as shown by the immiscible sulfide blebs they contain and their linear trend on a plot of FeO versus S \cite{1}. PGE and S contents of continental flood basalts (CFB) suggest that they erupted undersaturated with sulfide and further, that mantle sulfide was exhausted during melting. However, S contents for these lavas can only be inferred from rock values because they are not glassy and/or have degassed at low pressures. Submarine MORB glasses are better for judging S undersaturation because they are rapidly-quenched liquids that erupted under hydrostatic pressures sufficiently high to preserve magmatic S without degassing. Here, using FeO-versus S relationships and Cu contents in glasses, we show for the first time that certain MORB and oceanic plateau basalts were sulfide undersaturated when erupted. In some cases they may have exhausted mantle sulfide during melting. The S-undersaturated basalts are MORB from Kolbeinsey Ridge and Indian Ocean ridges and have low Na\textsubscript{8.0}. Also, low-Na tholeiites from Ontong Java Plateau (OJP) and environs. All have formed by large extents of melting. Additional S-undersaturated MORB from the Indian Ocean that have formed by smaller extents of melting suggest that the mantle source is regionally depleted in S compared to other areas. Sulfide undersaturation there might correlate with an Indian Ocean isotopic signature, pointing to a peculiar makeup of the source.

We consider the behavior of S, Cu and PGEs in terms of a column melting model \cite{2} and the negative pressure dependence, the positive temperature (T) dependence and the compositional dependences of the S content at sulfide saturation (SCSS) \cite{3,4}. Most magmas should reach crustal levels undersaturated with sulfide [3], but rapidly become saturated as T decreases and they evolve by olivine crystallization. Unlike [3] we feel that changes in T and composition are sufficient to bring about sulfide saturation: assimilation is not required. Differences in extent of melting should affect S saturation history. Average MORB that form by moderate extents of melting at relatively shallow depths will not be too far removed from sulfide saturation, and can rapidly attain saturation as T decreases and 10-20\% olivine crystallizes, most likely in the lower crust and uppermost mantle. Basalts from OJP and Kolbeinsey that form by large extents of melting will reach the crust as picrites that are much farther from S saturation. They are more likely to erupt S-undersaturated, and able to "deliver" PGEs to shallower levels. Cumulates could have high PGE concentrations at the point of sulfide saturation. The residual mantle could be very heterogeneous with respect to S, Cu and PGEs. Uppermost mantle is likely to be highly melted and depleted in S and PGEs. Deeper levels should preserve more PGEs and S. Since sulfide should dissolve quickly into silicate liquid, ascending S-undersaturated magmas are likely to strip sulfide + PGEs from the uppermost mantle they pass through, even if they do not cause additional melting or re-equilibrate with REE.