Testing the role of chalcophile element fertility on VMS mineralization: PGE geochemistry of the volcanic rocks associated with the Jaguar and Bentley Cu-Zn VMS deposits, Western Australia

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We investigated the platinum-group element (PGE) geochemistry of volcanic rocks from the Teutonic Bore complex, which hosts the Jaguar and Bentley Cu-Zn VMS deposits, in order to understand the sulfide saturation history and to constrain the role of chalcophile element fertility on the formation of volcanogenic massive sulfide (VMS) deposits.

The Jaguar and Bentley volcanic rocks are composed of basalt, andesite, dacite, and rhyolite. They show similar primitive mantle-normalized trace element patterns and continuous variations in trace elements and PGE with increasing fractionation indices such as Yb, suggesting a comagmatic origin. The PGE behave incompatibly in the early stage of magma differentiation at < 4 ppm Yb, whereas they abruptly decrease at > 4 ppm Yb, indicating sulfide saturation at this point. When Pd/MgO and Pd/Pt are used as chalcophile element fertility indicators, the andesite before sulfide saturation (< 4 ppm Yb) has the values as high as the magmas associated with porphyry Cu-only deposits, but are 5-10 times lower than those of andesite and dacite from the modern Au-rich seafloor massive sulfide deposits. This is consistent with the Au-poor nature of the Jaguar and Bentley Cu-Zn VMS deposits. These results imply that sulfide-undersaturated andesite may have been a major source for Cu in the Jaguar and Bentley and that ore formation occurred shortly after sulfide saturation so that Au was largely stripped from the silicate melt whereas Cu was little affected. Our study shows that chalcophile element fertility may play an important role in the formation of VMS deposits, especially in controlling the Au contents of the ore, if the magmatic hydrothermal component is the dominant source for metals in VMS systems.