Derivation of the Columbia River Flood Basalts by plume emplacement and delamination against the cratonic margin of North America

V.E. CAMP* AND B.B. HANAN

Department of Geological Sciences, San Diego State University, San Diego, CA 92182, USA
(*correspondence: vcamp@geology.sdsu.edu)
(bhanan@geology.sdsu.edu)

The Grande Ronde Basalt Formation comprises ~65% of the Columbia River Basalt Group (CRBG), but over 90% of the volume that erupted from the Chief Joseph dike swarm of northeastern Oregon and southwestern Washington. These lavas are composed of high Fe/Mg, high-silica (52-57%) basaltic andesites that are unusual, and perhaps unique, when compared to the most dominant rock types comprising the bulk composition of flood-basalt provinces worldwide. We believe that this important distinction requires a genesis that is atypical of the lavas generated during the climax stage of all other flood-basalt provinces.

The melting experiments of Takahahshi *et al.* (1998) suggests that the Grande Ronde lavas were derived from direct melting of mafic crust composed of pyroxenite or eclogite at a depth of ~70 km (~2.0 GPa). Such a process requires placing mafic crust at a depth below the presumed crust-mantle boundary underlying the Chief Joseph dike swarm. This could be accomplished by a "bottom-up" process involving the ascent of an eclogite-bearing plume (Takahahshi *et al.*, 1998), or by a "top-down" process involving the decent of mafic lower crust by delamination (Hales *et al.*, 2005).

The Chief Joseph dike swarm is underlain by Mesozoic accreted arc terranes lying adjacent to the Precambrian boundary of North America. The Pb, Sr, Nd, and Re-Os isotopic signature of Grande Ronde Basalt is consistent with a primary source component of mafic lower crust derived from these accreted terranes, mixed with a smaller component derived from the Yellowstone mantle plume head. A model of plume-triggered delamination is consistent with age-progressive chemical variations seen in the CRBG stratigraphic record, and with the recent thermo-mechanical experiments of Burov *et al.* (2007) demonstrating that slab-like delamination is the expected result of plume-impingement against cratonic boundaries. The uplift history, stress regimes, and structural profile predicted by the experiments of Burov *et al.* (2007) are identical to those observed above the presumed plume head beneath eastern Oregon and adjacent Washington States.

Oxygen fugacity profile in the Earth's lower mantle

A.J. CAMPBELL*

Dept. of Geology, University of Maryland, College Park, MD 20742, USA (*correspondence: ajc@umd.edu)

Oxygen fugacity (fO_2) greatly influences many physical and chemical properties, including phase equilibria, element partitioning, and diffusion and rheological properties. However, the oxygen fugacity profile in the Earth's deep interior has remained uncertain. It is recognized that the uppermost mantle is oxidized, near the FMQ buffer, whereas the lowermost mantle is reduced, being in contact with a large reservoir of iron-rich metal at the core-mantle boundary (hence below the IW buffer). Less certain is the depth profile of fO_2 between these limits.

Experimental work [1, 2] has demonstrated that metallic iron can coexist with ferric iron under mantle P,T conditions. Ferric iron is produced by dissociation of FeO, and incorporated into silicate perovskite principally as an $FeAlO_3$-pv component in the lower mantle. Recently we have extended the fO_2 buffers for several metal-oxide systems, including iron-wüstite, to high pressure conditions using equation of state data up to 85 GPa [3]. A ferrous-ferric iron buffer can likewise be proposed using the limited thermodynamic data available for $FeAlO_3$ [4, 5]. The dissociation of FeO to metal plus ferric iron [1] can be treated as a coupling of these two buffers.

Incorporation of these thermodynamic data into an extended data set for lower mantle silicate mineralogy [6] shows that the high density of the $FeAlO_3$-pv component drives dissociation of FeO with increasing pressure. Hence, metallic iron is expected to be produced under lower mantle conditions, providing a thermodynamic basis to the experimental observations [1]. For a specified primitive mantle bulk composition, uniform with depth, the fO_2 in the lower mantle is fixed by the partitioning of metallic, ferrous and ferric iron that is calculated from the model assuming ideal solution behavior. The results show that the Earth's lower mantle becomes progressively more reduced, relative to IW, with increasing depth.

[1] Frost *et al*. (2004) *Nature* **428**, 409-412. [2] Rohrbach *et al.* (2007) *Nature* **449**, 456-458. [3] Campbell *et al.* (2007) *EOS Trans. AGU*, Abstract MR23D-08. [4] Majzlan *et al.* (2002) *Phys. Chem. Minerals* **29**, 515-526. [5] Gramsch & Prewitt (2002) *EOS Trans. AGU*, Abstract MR62B-1084. [6] Stixrude & Lithgow-Bertelloni (2007) *Earth Planet. Sci. Lett.* **263**, 45-55.