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Magma mixing in the Yellowstone Plateau Volcanic Field brought to light by X-ray microtomography and chemical analysis

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The Yellowstone Plateau Volcanic Field (YVF) hosts at least four mixed magma complexes (Wilcox, 1944; Christiansen et al. 2007; Pritchard et al., 2013). We focus on the well-exposed Grizzly Lake complex. The main evidence of mixing in igneous rocks is commonly found as textural heterogeneities, such as i) flow structures, ii) magmatic enclaves and iii) physico-chemical disequilibria in melt and crystals (e.g. Perugini and Poli, 2012). From the geochemical and mineralogical point of view, quantitative and qualitative analyses of chemical and textural heterogeneity in mixed rocks highlights the important role of mixing dynamics in producing geochemical complexities and heterogeneities (Kratzmann et al., 2009). Zoned crystals and complex mineralogical associations are also considered, in many cases, evidence for mixing (e.g., Murphy at al., 1998; Couch et al., 2001). The generation of such textures implies the development of large contact interfaces between interacting melts/solids through which chemical and crystals exchanges are strongly amplified, leading to highly variable degrees of homogenization depending on differing element mobility (e.g. Perugini et al., 2006; 2008; De Campos et al., 2011; Perugini et al., 2012; Perugini and Poli, 2012; Morgavi et al., 2013a, b, c). Despite the abundant literature regarding magma mixing processes, only a few studies are focused on describing and quantifying the inter-relationship between the morphological texture of mixing patterns and the geochemical variability in mixed rhyolitic and basaltic complexes. (Freundt and Schmincke 1992; Morgavi et al., 2013 a, b, c;). Here, we combine two analytical techniques; X-ray computed microtomography and microprobe analysis to study the texture and chemistry of mixed rocks. Since mixed rocks of Grizzly Lake in the YVF had a very complex history and evolution, a significant amount of chemical measurements were needed to characterize the phases. In addition, X-ray microtomography was required to investigate and describe mixing texture, such as vesicle size and distribution, crystal distribution, as well as the morphology of filaments and enclaves via fractal dimensions. Mixed eruptions such as those described in this work are both rare and vital resources for providing a substantial amount of information about the evolution of complex large bimodal magmatic systems. Perhaps the frequency and importance of magma mixing between basaltic and rhyolitic compositions has been largely overlooked because mixed assemblages are often difficult to identify. Thus, a review on the magma mixing texture and petrogenetic significance of mixing is appropriate and needed for this geologic area.