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A geochemical study of the lava domes of the Tschicoma Formation, Jemez Mountains, and their relationship with the Bandelier Tuff, New Mexico, USA

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The Tschicoma Formation is a collection of dacitic to rhyodacitic lava domes and flows in the Jemez Mountains of New Mexico. Part of the Jemez Mountains Volcanic Field, the bulk of the Tschicoma material was erupted between 2 and 5 Ma and is preserved to the north and northeast of Valles Caldera, which itself formed between 1.6 and 1.1 Ma due to the eruption of the Bandelier Tuff. The Bandelier Tuff, erupted as the Lower Bandelier Tuff and Upper Bandelier Tuff, consist mostly of high-Si rhyolite, except for a small volume of dacitic pumices found in the Upper Bandelier Tuff. Previous mapping studies have delineated and dated distinct Tschicoma domes to the east of the caldera, yet detailed geochemical data for these domes is sparse. The aim of this study is to perform a comprehensive geochemical investigation of the Tschicoma Formation and its relationship with the younger, yet geographically adjacent Bandelier Tuff, using major, trace element and isotopic compositional data.

We collected representative samples from the different lava domes of the Tschicoma Formation in order to examine the geochemical variability between domes, but also took care to collect enough samples from each dome so as to identify any potential compositional variability within the dome. In the major elements, the different domes plot on a continuous trends with very limited compositional differences within each dome. In the trace elements however, we see clear differences, with the Rendija Canyon Rhyodacite and Caballo Dacite units clearly standing out from the other domes, with lower Sr (255 - 292 ppm), higher Rb (102 - 133 ppm) and higher Th (18 - 25 ppm) compared to the other domes, which have Sr > 374 ppm, Rb < 78 ppm and Th < 14 ppm. The contrast with the composition of the Bandelier Tuff, particularly the dacitic pumices found in the Upper Bandelier Tuff, is even larger, which indicates the Bandelier dacite might not be as similar to the Tschicoma dacite as was suggested in previous studies. Preliminary isotopic analyses indicate the different domes are also isotopically distinct, with for instance higher 176Hf/177Hf for Sowyer Dome and Rendija Canyon (0.282863 - 0.282870) compared to the other domes (176Hf/177Hf < 0.282829), while the contrast between Tschicoma dacite and Bandelier dacite becomes very distinct in 87Sr/86Sr (0.703566 for Bandelier dacite, 0.704437 – 0.704916 for Tschicoma domes).

The relationship between the Tschicoma Formation and the Bandelier Tuff, and the origin of this Bandelier dacite have important implications for the longevity of magma production. If the dacitic magma that was erupted with the Bandelier Tuff had a similar source as the far older Tschicoma dacite, it would mean the processes forming the Tschicoma magmas were still active at the time the Upper Bandelier Tuff erupted. These magma-forming processes would thus have persisted for far longer than previously thought, which would have implications for our perception of the longevity of magma chambers.