Seven Quaternary topaz-style rhyolite domes are present in the bimodal basalt-rhyolite Blackfoot Volcanic Field (BVF). The high silica, slightly metaluminous rhyolites average ~10% crystals in their glassy carapace (quartz > sanidine > plagioclase > hornblende ≈ biotite > magnetite > ilmenite) and contain trace phases of zircon >> apatite, +/- allanite, +/- thorite. As compared to other physio-tectonic rhyolites, the BVF rhyolites are high in Cs, Ta, Yb, U, and Th and low in FeO(t), Sc, Sr, LREE, and Eu. The three, aligned domes of the Central Dome Field (CDF) are especially high in Rb and low in Sr resulting in Rb/Sr ratios approaching 250. Another distinction of BVF rhyolites from other rhyolites are very low La/Yb ratios, with the CDF ratio near unity.

The young (~50 ka) CDF was emplaced after localized basalt flows and normal faulting. It began with hydrovolcanic tephra production and subsequent tephra and endogenous dome growth overlap. Other features in the CDF related to the rhyolite emplacement include local tumescence and collapse crater formation and partial dome collapse resulting in hummocky terrain.

All of the phenocryst phases, except quartz, are in textural equilibrium with the melt. The CDF magma equilibrated at ~3.5 kbars (13 km deep), at a temperature of ~760°C with a log fO2 of -14.5. The presence of granophyric texture in the three, aligned domes of the Northern Dome Field (NDF) may indicate a shallower equilibration depth coupled with a depressurization and volatile loss event.

Fractional melting of either upper or lower crust or a combination of the two has been ruled out as a possible genesis scenario for the BVF rhyolites based on both isotopic and trace element constraints. Limited upper crustal assimilation coupled with fractional crystallization (AFC) models, similar to those models used to generate geochemically similar Quaternary rhyolite domes in the adjacent eastern Snake River Plain (ESRP) province (McCurry et al., 1999), can explain both the trace element and isotopic signatures in the rhyolites using local basalts of the BVF as a parent material. Results indicate that 9 to 18 percent upper crustal assimilation into the basalt followed by extensive fractional crystallization can form the CDF rhyolites. Basaltic recharge to the system that occurred just prior to eruption was very minor and did not affect the trace element concentrations or isotope ratios in the rhyolitic magma.

The ability to melt the upper crust greatly controls the amount of assimilation in these AFC systems. The ~1.4 Ma NDF contains ~5 percent more crustal assimilant than the younger CDF because the crust under the CDF has become more refractory due to additional basalt injections over the past 1.4 Ma. The Quaternary ESRP rhyolites contain significantly less crustal assimilant as compared to the BVF rhyolites because the crust under the ESRP is even more refractory. This is a result of voluminous Tertiary rhyolite eruptions and significantly greater amounts of basalt flooding the crust for the past 2 Ma under the ESRP.