**SUPPLEMENTAL TEXT 1: LAVA FLOWS AND DOMES IN THE WESTERN NEVADA VOLCANIC FIELD**

**for Magmatism, Ash-flow Tuffs, and Calderas of the Ignimbrite Flareup in the Western Nevada Volcanic Field, Great Basin, USA**

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Lava flows and domes are a widespread but relatively small volume component of the western Nevada and adjacent central Nevada fields (Fig. 24). They commonly are the earliest manifestation of Tertiary magmatism within an area and often presage caldera-forming ignimbrite eruptions from the same area (Table 1). Where mapping is adequate, lava flows demonstrably underlie nearly all known calderas in the western Nevada field, but most seem to have small volumes, are 100s of thousands to several million years older than associated calderas, and range in composition from high-silica rhyolite to mafic andesite with rhyolites especially common in the central part of the field in the southern Stillwater Range and Clan Alpine Mountains (Figs. 24 and 25). Most larger volumes and areas underlain by lava flows and domes are >5-10 km distant from known calderas and appear unrelated to caldera-forming volcanism. Post-caldera, intermediate composition lava flows are present in some calderas, most notably in the Job Canyon caldera in the Stillwater Range. Silicic (rhyolite) domes and related lava flows are present in most calderas and represent resurgent magmas emplaced shortly after caldera formation.

Exposures of lava flows and domes within the western Nevada volcanic field include (Fig. 24):

Northern Toiyabe Range (NTR)—Small areas of hornblende and pyroxene andesite lava and block and ash flows (35.2 Ma) locally underlie and form the floor of the 34.0 Ma Caetano caldera (Colgan et al., 2011). Numerous silicic dikes and small flow domes (35.7 and 38.9 Ma Cortez dikes) that crop out along the northeast corner of the

Caetano caldera and extend north across Crescent Valley into the Tenabo area are the earliest Tertiary rocks in this region.

Toiyabe Range between the Caetano and Hall Creek calderas (TR)—These rocks include finely to coarsely porphyritic hornblende andesite lava flows that underlie the 34.0 Ma Hall Creek caldera.

Northern Shoshone Range (NSR)—Porphyritic pyroxene andesite lava flows that are interbedded in volcaniclastic sedimentary rocks locally infill the western part of the 34.0 Ma Caetano caldera (Colgan et al., 2011) and extend west to the east side of Fish Creek Mountains (FCM). The tuff of Campbell Creek (28.9 Ma) locally overlies the lava flows. These rocks also include a thick sequence of ca. 34 Ma porphyritic dacite lavas flows that lie south of the Caetano caldera and extend 15 km south nearly to Reese River Narrows (Moore and O'Sullivan, 2005).

Fish Creek Mountains (FCM)—Abundant porphyritic andesite-dacite lava flows interbedded with volcaniclastic sedimentary rocks and 34 to 33 Ma silicic flow domes are exposed on the east, west, and north sides of the Fish Creek Mountains caldera (McKee, 1970; Emmons and Eng, 1995). The Caetano Tuff and the tuff of Campbell Creek locally overlie these lava flows and sedimentary rocks.

Tobin Range (TBR)—These rocks include mafic lava flows that underlie the 34 Ma Caetano Tuff and as much as 700 m of andesite-dacite lava and debris flows and minor pyroclastic rocks about 33 Ma that lie between the 34 Ma Caetano Tuff and the 24.9 Ma Fish Creek Mountains Tuff (Gonsior and Dilles, 2008). These rocks were deposited in a broad mid-Tertiary valley that parallels the modern Golconda Canyon (Burke and McKee, 1979; Gonsior and Dilles, 2008).

Clan Alpine Mountains (CA)—Ca. 35 Ma hornblende and pyroxene andesite lava flows and volcaniclastic rocks are the oldest Tertiary rocks in this area and form part of the topographic wall of the 29 Ma Deep Canyon caldera (Figs. 24 and 25; Riehle et al., 1972; Hardyman et al., 1988). Both the Deep Canyon and ca. 25 Ma Railroad Ridge

calderas are partly ringed by poorly dated rhyolite intrusions; some of these intrude the tuff of Railroad Canyon and others appear to be older and lithologically similar to the basal rhyolite dome complex that underlies the Stillwater caldera complex 20 km to the west (John, 1995).

Central Stillwater Range (CSR)—Undated basaltic andesite and porphyritic low-silica rhyolite lava flows are the oldest Tertiary rocks in this area (Page, 1965; this study) and underlie the tuff of McCoy Mine(?) (29.4 Ma) and the Nine Hill (25.4) and New Pass Tuffs (25.2 Ma).

Southern Stillwater Range (SCC)—The northern part of ca. 29.5 to 25 Ma Stillwater caldera complex (John, 1995) is underlain by a large (2 km exposed thickness), undated (31-30? Ma) rhyolite flow dome complex. The rhyolites extend east across Dixie Valley to the Louderback Mountains (LM) and southwestern Clan Alpine Mountains, where they underlie outflow tuff of Job Canyon and the Elevenmile Canyon caldera. Andesite-dacite lava flows and breccias as much as 1.5 km thick and a sill and dike complex underlie the Job Canyon caldera and have an inferred genetic relationship to the ca. 29.4 Ma caldera-forming tuff of Job Canyon. As much as 2 km of andesite-dacite lava flows and breccias fill the north half of the Job Canyon caldera and are interpreted as resurgent magmas from the Job Canyon caldera system. The nested ca. 25 Ma Elevenmile Canyon and Poco Canyon calderas are overlain and intruded by large rhyolite to dacite lava domes and hypabyssal intrusions (ca. 25 to 20 Ma).

Fairview Peak area (FP)—A wide range of rock types with diverse ages crop out around the 19.5 Ma Fairview Peak caldera (Henry 1996a, b, and unpub. mapping). Pre-31.5 Ma mafic andesites (55-58% $SiO_2$) south of the caldera are the oldest of these lavas. Andesite to dacite lavas (60 to 64% $SiO_2$) and minor tuffs north of the caldera are 22.8 Ma. At about 20.3 Ma, a heterogeneous group of mostly dacite and rhyolite domes and lavas (63, 66, and 76% $SiO_2$) were emplaced north and south of the caldera; these were accompanied by several thin flows of basaltic andesite (55% $SiO_2$) in the south. After

eruption of the caldera-forming ash-flow tuff at 19.5 Ma, numerous rhyolitic to dacitic domes (76 to 68% $SiO_2$) were emplaced along the caldera ring fracture and similar east-striking dikes intruded in the caldera between 19.3 and 18.8 Ma. The more silicic rocks south of the caldera are overlain by possibly coeval (but undated) andesite to basalt lavas (61 to 52% $SiO_2$).

Northern Paradise Range (Bruner district, BD)—A large ca. 20 Ma rhyolite dome complex intrudes distally sourced ignimbrites including the 23.3 Ma tuff of Toiyabe (Santiago Canyon Tuff).

Southern Paradise Range (PR)—Abundant hornblende-biotite andesite and dacite lava flows and breccias locally >400 m thick underlie and are locally interbedded with distally sourced ignimbrites in the southern Paradise Range and northern Pactolus Hills (John, 1992a). The lavas are poorly dated but most are probably ca. 26 to 24 Ma.

Royston Hills (RH)—Hornblende andesite lava flows form the basal Tertiary unit. Numerous pyroxene and hornblende andesite lava flows are interbedded in overlying, distally sourced, ca. 29 to 26 Ma ignimbrites (Whitebread and Hardyman, 1987).

Southern Toiyabe Range (STR)—Andesite lava flows locally overlie the 24.5 Ma tuff of Peavine Canyon and partly fill the Peavine caldera and underlie the 23.3 tuff of Toiyabe (Whitebread and John, 1992).

Toquima Range (TQ)—Numerous silicic to intermediate lavas and intrusions were emplaced in the Toquima Range before, during, and after caldera formation in this area. Numerous K-Ar and fission-track dates (Fig. 18; Shawe et al., 1986; Shawe, 1995) indicate that a small granodiorite stock (ca. 2 by 0.6 km; 62-65% $SiO_2$) and a northeast-striking swarm of rhyolite (72-78% $SiO_2$) and lesser andesite (59-63% $SiO_2$) dikes intruded Cretaceous granite east of the Round Mountain caldera between ca. 37 and 34 Ma. Rhyolite dikes (77% $SiO_2$) and dacite to andesite(?) lavas (68% $SiO_2$) were emplaced between 35.6 and 35.4 Ma east of the Northumberland caldera before its eruption at 32.9 Ma (this study). $^{40}Ar/^{39}Ar$ ages for numerous rhyolite domes (78 to 73% $SiO_2$) emplaced

along the ring fracture of the 27.3 Ma lower Mount Jefferson caldera are coeval with caldera formation and indicate that these domes were emplaced almost immediately after ash-flow eruption (Fig. 18). $^{40}Ar/^{39}Ar$ ages for numerous rhyolite (76-78% $SiO_2$) and dacite (69% $SiO_2$) domes emplaced along the ring fracture of the 27.0 Ma upper Mount Jefferson caldera indicate that these domes are also coeval with caldera formation and were also emplaced almost immediately after ash-flow eruption. KAr ages and field relations suggest that several rhyolite to andesite plugs and lava domes and lavas were emplaced inside the Manhattan caldera shortly after its eruption (Shawe et al., 1986; Shawe, 1999a).

Gabbs Valley Range (GVR)—This area on the east side of the Walker Lane and includes several sequences of lava flows interbedded with regionally widespread ignimbrites (e.g., Singatse and Mickey Pass Tuffs; Table 2) and with additional local tuffs that probably are small volume pyroclastic units related to lava dome formation. Major lava flow units include the >27 Ma lavas of Giroux Valley and those in the ca. 23 Ma Hu-Pwi Rhyodacite, a composite tuff and lava unit (Ekren et al., 1980). Only a single chemical analysis of an andesite lava flow in the Hu-Pwi Rhyodacite with 60.4% $SiO_2$ is available for these rocks; Ekren et al. (1980) indicate that they include andesite, latite, and rhyodacite compositions.

In addition to the exposures mentioned above, large areas just outside the western Nevada volcanic field in the Emigrant Pass area and in the Simpson Park Range are underlain by late Eocene lava flows and lava domes.

In the Emigrant Pass (EP) area near the north edge of the western Nevada volcanic field, numerous lava flows, flow breccias, and shallow andesite to rhyolite intrusions were emplaced in four distinct groups between 38.3 and 36.4 Ma (Figs. 24 and 25; Henry and Faulds, 1999; Ressel and Henry, 2006). A voluminous series (at least 30 $km^3$) of dominantly finely and abundantly porphyritic andesite and lesser dacite (60 to 65% $SiO_2$, mostly ≤63%) erupted between 38.3 and 38.1 Ma. A second sequence (at least

5 $km^3$) of phenocryst-rich, more coarsely porphyritic dacite and lesser andesite (60 to 67% $SiO_2$, only one analyzed sample <63% $SiO_2$) erupted between 38.1 and 37.8 Ma. A single, extensive andesite lava (57% $SiO_2$, at least 3 $km^3$) characterized by abundant (ca. 10-12%) hornblende and almost no plagioclase phenocrysts erupted at 37.7 Ma. Two groups of coarsely porphyritic dikes, rhyolite containing about 75% $SiO_2$ and dacite containing 65 to 71% $SiO_2$, intruded between 36.7 and 36.4 Ma.

In the Simpson Park Range (SPR) along the northwest side of the adjacent central Nevada volcanic field, lava flows and domes ranging in composition from andesite to rhyolite are discontinuously exposed for about 80 km from Fye Canyon (FC) in the north to US Highway 50 about 10 km south of Bates Mountain (BM). Major exposures include the 35.7 Ma andesite to rhyolite flows and plugs of the volcanic rocks of Fye Canyon and Twin Peaks (Gilluly and Masursky, 1965; McKee and Conrad, 1994) and ca. 36-35 Ma andesite and dacite lava flows locally >600 m thick that form the basal Tertiary unit in the Bates Mountain area (McKee, 1968; Stewart and McKee, 1968). The latter exposure was interpreted as a large stratovolcano by McKee (1968).

Chemical analyses of about 160 lava and lava dome samples scattered among these exposures have a wide range of compositions from high-silica rhyolite to basaltic andesite, although rocks with <57% $SiO_2$ are rare and restricted to the undated lavas south of Fairview Peak (Fig. 25). The rocks are relatively $K_2O$ rich and most form a high-K calc alkaline series. Early rhyolites that underlie the Stillwater caldera complex and post-Caetano caldera andesites are notably $K_2O$ rich. Samples from the western centers (Stillwater, Fairview Peak, Paradise Range) generally are more alkaline than samples collected farther east (Emigrant Pass, Fye Canyon, Bates Mountain), mostly as a consequence of higher $Na_2O$ contents.

References (not in main report)

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