GRANITE FALLS STOCK AND THE HANSEN LAKE RHYOLITE—A HISTORY OF SYN-TECTONIC EOCENE MAGMATISM AND UPLIFT IN THE PILCHUCK RIVER VALLEY DURING REGIONAL TRANSTENSION, SNOHOMISH COUNTY, WASHINGTON

ABSTRACT

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Our new mapping, U-Pb zircon dating, geochemistry, and isotopic data shows that ~43–45 Ma igneous rocks in the Pilchuck Valley preserve a history of Eocene syn-tectonic intrusion and uplift during regional transtension. The Bald Mountain Pluton (BMP), Mount Pilchuck Stock (MPS), and Granite Falls Stock are mapped to regional transtensions in the Pilchuck River valley where emplacement was controlled by bounding faults (Fig. 1). The ~43 Ma Granite Falls rhyolite exposed directly south of Granite Falls Stock (Fig. 2 and full quadrangle map to the right of this paper) is an extrusive equivalent of the metarhyolite ~44–45 Ma Granite Falls Stock. The Hansen Lake rhyolite and ~44 Ma BMP and MPS constitute a slightly older ~40 Ma comagmatic package preserved to the east in the upper Pilchuck River valley (Fig. 1). The contact complex bounding the Granite Falls Stock main phase consists of intermediate to felsic aphaniitic to porphyritic dikes, and melas to intermediate, mesozonal to epizonal intrusive bodies (Figs. 3–5). Early dikes are contact metamorphosed by later intrusions.

The contact complex and main Granite Falls Stock syn-tectonically intruded into conjugate ENE and NWW trending fault zones that bound the stock and controlled magmatic emplacement paths (Fig. 4). In the “pull-apart basin” intrusive model space was created by dilation across conjugate NE-trending transtensional faults and extensive transpressional to transcurrental faults (Fig. 1). Geological, tectonic, and geochronological constraints, geochemistry, and field relations suggest that diking generally occurred after ~44 Ma Granite Falls Stock during NWS-directed regional transtension.

Geothermobarometry and mapping indicate the Bald Mountain Pluton and Mount Pilchuck Stock crystallized at depths of 15–20 km whereas the Granite Falls Stock was shallowed emplaced (17-24 km) and led the Granite Falls rhyolite and contact complexes of the Granite Falls Stock. This suggests ~10 km to perhaps as much as 10 km of mid-Eocene uplift along the Pilchuck River Fault, a regional fault mapped regionally (Fig. 7). This combination of mid-Eocene extension, uplift, and crustal melting in a tectonic setting support Farallon slab breakoff beneath the North America plate with generation of the SW-directed Tintac arc as being responses to asthenospheric upwelling through a gap in the slab (Fig. 8).

From McCrory et al (2009)

Figure 7. Structural Model. Cross-cutting faulted and intrusive age history of the contact complex (CC) and Granite Falls Stock (GFS) stock intrusions. The CC and GFS syn-tectonically intruded into conjugate ENE and NWW trending fault zones that bound the GFS and controlled magmatic emplacement paths. In this the “pull-apart basin” intrusive model space was created by dilation across conjugate NE-trending transtensional faults and NW directed transtensional to transcurrental faults. An extensional tectonic model fits with the observation of contemporaneous regional sedimentary basins and is consistent with the observation that the Eocene intrusive rocks in the Pilchuck valley are largely comagmatic and bounded by faults. The model explains these key observations: ~43–45 Ma ages of the andesite dikes, Granite Falls rhyolite, and GFS main phase.

• dikes intrude faults but are cut again by later faults of the Granite Falls and Bald Mountain plutons.
• The GFS intruded the CC dikes (Fig. 4, b) and Cu out the main stock, and
• the more-felsic andesite dikes are geochemically and isotopically similar to the GFS (Figs. 5, 6A-B).

Figure 4. Cross-cutting relations of unit Eian. A) Porphyritic dike cross cutting sheared meta-argillite in the Western mélange belt (unit Kwas, in Fig. 2). This exposure is in the Pilchuck River in the SE portion of the quadrangle. It is one of a family of dikes mapped along the Pilchuck River directly south of the Carpenter Creek fault (CCF) and within the northeastern part of the Granite Falls Stock. These Eocene dikes trend east-northeast and we hypothesize are related to Eocene extension (Fig. 7). B) Well exposed intrusive relationship between the Granite Falls Stock and Eian Main phase granodiorite and contact complex (dark rock bounded by black line). This outcrop is part of a series of exceptional rock exposures in the South Fork Dillapioles Valley. Granodiorite of the Granite Falls Stock intrudes aphanitic country rock of Eian. However, because we also observed dikes intruding the stock we broadly envision a comagmatic history for these ~44–45 Ma intrusive bodies. We postulate a syn-tectonic intrusive history during regional Eocene transtensions for these igneous rocks because the dikes in the contact complex intrude faults and are then again faulted locally by the faults bounding Eocene igneous bodies (Fig. 7).

• the more-felsic andesite dikes are geochemically and isotopically similar to the GFS (Fig. 5, 6A-B).