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Evolution and geochemistry of the Tertiary calc-alkaline plutons in the Adak Island region of the central Aleutian oceanic island arc

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Calc-alkaline plutons are major crustal building blocks of continental margin mountain belts like the Mesozoic to Tertiary Andes and the Sierra Nevada, but are rare in oceanic island arcs. Some of the most calc-alkaline I-type island arc plutons are in the Central Aleutians with the most extreme signatures, as indicated by FeO/MgO ratios of < ∼2 at 48-70% wt. % SiO_2, in the ∼10 km wide Oligocene Hidden Bay pluton on southern Adak Island and the 10 km wide Miocene Kagalaska pluton to the north on eastern Adak and the adjacent Kagalaska Island. Although small compared to most continental plutons, similarities in intrusive units, mineralogy and chemistry suggest common formation processes. The Aleutian calc-alkaline plutonic rocks mainly differ from continental plutons in having more oceanic like isotopic (87Sr/86Sr = 0.703-0.7033; Epsilon Nd = 9-7.8) and LIL (e.g., higher K/Rb) ratios. The Adak region plutons differ from Tertiary plutons on Unalaska Island further east in being more K-rich and in having a more oxidized and lower-temperature mineralogy. From a regional perspective, the Adak area plutons intrude Eocene/Oligocene Finger Bay Formation mafic volcanic and sedimentary rocks and postdate the small ∼38 Ma tholeiitic Finger Bay pluton. The chemistry of these older magmatic rocks is basically similar to that of young Central Aleutian magmatic rocks with boninites and arc tholeiitic magmas seemingly being absent. The formation of the calc-alkaline plutons seems to require a sufficient crustal thickness, fluid concentration and contractional stress such that magma chambers can stabilize significant amounts of pargasitic hornblende. Seismic receiver function analyses (Janiszewski et al., 2013) indicate the modern Adak crust is ∼ 37 km thick. Existing and new hornblende, plagioclase and biotite Ar/Ar ages from 16 Hidden Bay pluton and Gannet Lake stock gabbro, porphyritic diorite, diorite, granodiorite, leucogranodiorite and aplite samples range from 34.6 to 30.9 Ma and indicate an ∼ 4 Ma intrusion history. Biotite Ar/Ar ages for Kagalaska gabbro and granodiorite samples range from 14.7 to 13.9 Ma. The new ages are consistent with the plutons being related to several eruptive centers and forming during the waning stages of volcanism as the magmatic arc front was displaced to the north, possibly in response to accelerated periods of forearc subduction erosion. The gabbroic to leucogranodioritic units evolved in the lower to mid-crust with more silicic magmas rising buoyantly to higher levels where final crystallization and segregation of aplites occurred. Most gabbro and all mafic diorite units are largely crystal cumulates; one gabbro approaches the melt composition of a high Al basalt. The volumetrically dominant silicic diorites and granodiorites (58-63% SiO_2) show the most zoning in their mineral phases and approach melt compositions. The leucogranodiorite (67-70% SiO_2)unit was the last to crystallize. The silicic units are considered to be deep-crustal differentiates of high-Al basalt magmas, although partial melting of older magmatic rocks may play a role. Mafic dikes in the pluton represent the basic magmas under the dying arc front as the front moved northward.