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Glaciovolcanism and episodic ice-sheets: evidence for paleo-climate proxies and insights into eruption dynamics from the Kawdy-Tuya area of northern British Columbia

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Constraints on pre-LGM ice-sheet positions and characteristics in North America have been hampered by the difficulty of identifying features that formed before the LGM and survived its immense erosive powers. Fortunately for paleo-climate reconstruction efforts in northwestern NA, sporadic volcanism accompanied the presence of ice over at least the last 2 Ma. Eruptions that were coincident with the presence of glaciovolcanic structures that withstood LGM erosion and that now preserve a record for pre-LGM ice presence, especially in northern British Columbia, Canada. Mathews (1947) first defined tuyas from the Kawdy-Tuya area in northern BC, and later workers (e.g. Gabrielse, 1970) defined the Tuya Formation as a formal, mappable, Pleistocene stratigraphic unit of volcanic deposits over this region. However, of the 40+ deposits mapped as Tuya Formation, up to one-third appear to have formed during subaerial eruptions. The presence of subaerial and glaciovoclanic deposits from the same volcanic field spanning 2 m.y. provides a unique opportunity to document major fluctuations in the Cordilleran ice sheet during the Pleistocene; Ar-Ar geochronology on glaciovolcanic deposits have already documented the presence of ice in the Kawdy area at $\sim$1.8 Ma (Edwards, Singer and Jicha, unpub.) and in the Tuya area at $\sim$740 ka (Edwards et al., in revision). Ongoing work will produce geochronologic constraints on 20-30 more subaerial and glaciovolcanic deposits over the next two years.

Recognizance and detailed fieldwork at 30+ volcanic centers in the Kawdy-Tuya area during 2009 documented a wide variety of features indicative of broader-scale and detailed constraints on glaciovolcanic processes, in part due to the variation in extent of erosion in the area. At least four distinctive glaciovolcanic landforms occur: 'classic' tuyas (e.g. Tuya Butte), compound tuyas (e.g. Tanker tuya), tindars (e.g. Caribou tindar), and compound glaciovolcanic cones (e.g. South Tuya). Each landform likely represents a different set of magmatic-ice conditions, potentially related to a combination of differing ice thicknesses and volumes of material erupted. Detailed observations that constrain more localized eruption-ice conditions include the presence of glacially-derived clasts as a component within dominantly volcaniclastic deposits; presumably ice-confined, steeply dipping, radially-jointed lava flows that locally directly overlie pillow lava; multiple passage zones with variable dips; and finer-grained, laminated sediments that may have formed by localized ponding of water on either small or possibly much larger spatial scales. Taken together, along with high precision Ar-Ar geochronometry, the glaciovolcanic deposits may provide the most detailed constraints on pre-LGM ice sheet presence in western North America yet documented.

References:

[1]Edwards, BR, Russell, JK, Simpson, K (in revision for Bull. Volc.) Physical and Chemical Evolution of Mathews Tuya, northern British Columbia, Canada: evidence for a pre-LGM Cordilleran icesheet, 32 manuscript pages, 11 figures, 2 tables.

[2]Gabrielse, H (1970) Geology of the Jennings River map-area, British Columbia (104-O): Geological Survey of Canada Paper 68-55, 37 p.

[3]Mathews, WH (1947) "Tuyas," flat-topped volcanoes in northern BC. Am J Sci 245, 560–570.