Multi-Disciplinary Evidence for a Large, Previously Unrecognized Caldera in the Islands of Four Mountains, Central Aleutian Arc, Alaska

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The Islands of the Four Mountains (IFM) are a volcanic archipelago in the central Aleutian arc comprised of six closely spaced stratovolcanoes (Carlisle, Cleveland, Herbert, Kagamil, Tana and Uliaga) and a number of subsidiary cinder cones and fissures. Mount Cleveland, an open-vent system, is one of the most persistently active volcanoes in North America over the past 20 years with eruptive activity characterized by small explosions that produce ash clouds that rise 15,000 to 30,000 feet asl and are often separated by effusive events that form small domes and flows. Recent analysis of seismicity, geologic deposits, structural trends, gas emissions, and gravity suggest that volcanism in the IFM may be influenced by a large previously unrecognized caldera that is largely hidden by recent deposits and the surrounding ocean. Evidence for this caldera includes:

1) Welded PDC ignimbrites occur on Tana and Carlisle consistent with local caldera-forming eruptions.

2) A ring-shaped free air gravity anomaly connecting Cleveland, Tana, Kagamil, Uliaga, and Carlisle volcanoes.

3) A circular distribution of closely spaced subaerial volcanic centers relative to adjacent portions of the arc.

Additional observations consistent with calderas worldwide include:

4) Complicated and arc-parallel alignments of volcanic vents and fissures between Cleveland and Tana.

5) Swarms of micro-earthquake with normal mechanisms at 5 - 10 km depth beneath Holocene aged vents between Cleveland and Tana that are suggestive of magmatic fluid migration.
6) High and sustained SO_2 flux at Mount Cleveland that requires connectivity to a larger magma source.
7) Gas samples on Tana Volcano, that are hydrothermal in character (CO_2>H_2S; no SO_2) with C and He isotopic signatures indicative of a magmatic source.

The northern extent of this possible structure is difficult to evaluate with these observations. Seismic tomography (Ps-P, from receiver functions) using a small aperture network suggests a narrow zone of strong low velocity beneath Cleveland that extends to 20 – 30 km depth. Additional geologic and geophysical studies including a broader network and bathymetry could reveal additional evidence for a caldera and areas of volcanic unrest in the IFM.