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Characterization of Archean subaqueous calderas: volcanic structure and geometry

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Calderas are well-documented volcanic structures but their Archean, and especially, ancient subaqueous counterparts are poorly documented. The Archean Blake River caldera complex, the Normetal caldera, and the Hunter Mine caldera of the Archean Abitibi greenstone belt show that the geometry and structures, which include the physical volcanology, are similar to modern analogues. The volcanic geometry is best shown in the Blake River caldera complex, a complete volcanic cross-section is given by the Normetal caldera, and the Hunter Mine caldera has a well-established moat facies. Focus is placed caldera recognition is ancient systems. The 2900 km2 Blake River caldera complex is composed of (i) the E-W trending 40x80 km Misema (2706 -2703 Ma), (ii) the NW-trending 14x35 km New Senator (ca. 2703-2700 Ma), and (iii) the NE-trending 15x20 km Noranda (ca. 2700-2696 Ma). The Misema caldera is an amalgamation of shield volcanoes with numerous summit calderas and extensive gabbro-diorite rift zones and numerous ring dyke complexes. The mafic dyke system was initiated during this Misema phase but continued during subsequent caldera events. The felsic-dominated New Senator and Noranda calderas are structurally bounded and are of the nested caldera variety. Major volcanic-hosted massive sulphide deposits are linked to these two events. Oblique subduction can account for the development of these NW- and NE-trending graben calderas, and modern analogues are found in South America (e.g. La Pacana). Major plutonic emplacement occurred during this stage, and the polyphase plutons are the exposed high-level magma chambers of the last two caldera-forming events.
Caldera-fill geometry is shown in the 2728 Ma Normetal caldera where mafic to felsic flow extrudes along the caldera margin faults. Identified faults are both reverse and normal, which is consistent with recent analogues models. Major hydrothermal carbonate alteration is observed along these synvolcanic fault systems. Only the last caldera stage is characterized by a large subaqueous eruption that mantles the edifice for at least 35 km along strike. The extensive 5 km-wide felsic dyke complex remains the striking feature of the 2734-2728 Ma Hunter Mine caldera. This central conduit, traceable 2.5 km up-section, represents the plumbing system of the edifice. Subaqueous fountain-fed pyroclastic deposits are interstratified with banded-iron formation, and both are cross-cut by the dyke system. Archean subaqueous calderas show all the hallmarks of modern subaqueous calderas, and can be used to better understand modern analogues, because they are exposed in cross-section.