



Magmatic plumbing of a Permian caldera exposed to a depth of 25 Km.

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We report discovery of a large caldera within a Permian bimodal volcanic field situated structurally above the Ivrea-Verbano Zone (IVZ) and Serie dei Laghi (SdL) of northwest Italy, two lithostratigraphic packages that constitute the deep- and the middle- to upper-crustal components, respectively, of a tilted and exposed section through the pre-Alpine crust of northwest Italy. A caldera diameter of ≥ 13 km is indicated by outcrops of rhyolitic megabreccia and intra-caldera tuff, and a contact between intra-caldera tuff and basement two-mica schist appears to be a relic of the caldera wall based on an increase in abundance of schist inclusions in the tuff as the contact is approached. A 7- to 8-km-thick granite of the SdL intrudes the volcanic rocks, grading downward from granophyre and fine-grained granite with miarolitic cavities near the volcanic rocks at its roof to a coarse-grained “mesogranite” that is rooted in migmatitic, metapelitic paragneiss of the IVZ. Intruding the IVZ paragneiss at deeper crustal levels is a ≥ 8 -km-thick gabbro complex; equilibration pressures at the roof of this complex indicate that it “underplated” beneath 15 to 20 km of crust. Most rhyolitic and SdL granitic rocks are peraluminous, consistent with an origin involving partial melting of metapelitic paragneiss in the IVZ. SHRIMP U-Pb zircon ages of bimodal volcanism (288 ± 2 to 282 ± 3 Ma), formation of granitic plutons in the SdL (289 ± 3 to 275 ± 5 Ma), and gabbro in the IVZ (289 ± 3 to 286 ± 6 Ma) indicate that the onset of bimodal volcanism and granitic plutonism was coincident with and probably triggered by intrusion of mantle-derived mafic melt in the deep crust, and that volcanic activity and presence of granitic melt at depth persisted after underplating had ceased. Palinspastic restoration of the Permian section provides a possible reference section for the crustal seismic structure beneath large calderas analogous to that provided by the ophiolite model for the seismic structure of the oceanic crust.