Archaean granites: classification, origin and tectonic implications

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The Archaean continental crust is dominated by granitoids, covering a large range of compositions and rock types. While several classification schemes exist for modern granitoids, there is relatively little application to Archaean rocks and a comprehensive terminology is lacking.

Similar to modern granitoids, Archaean rocks fall under three main groups: peralkaline granites; metaluminous granites and related rocks (granite to diorite); and metaluminous to peraluminous granites. Archaean peralkaline granites, although superficially similar to their modern counterparts, are mostly magnesian and lack the enrichments in trace elements that reflect, in the modern Earth, an origin related to fractionation of mafic melts derived from enriched mantle sources. Metaluminous granites (including sanukitoids) are, in some respect, similar to modern arc granites; but are no exact match to modern rocks, most likely pointing to different mantle enrichment processes in Archaean "subduction" environments. Metaluminous to peraluminous granites are formed by dehydration melting of mafic hydrous silicates and include potassic rocks, very similar to modern rocks and similarly generated by biotite dehydration melting; as well as sodic rocks (TTGs and low-pressure sodic granitoids), related to breakdown of amphibole (or of an equivalent eclogitic assemblage). Sodic granitoids can further be subdivided in low-pressure rocks (similar to rare, oceanic-plateau related granites, with the same apparent "arc" signature); medium-pressure TTGs; and high-pressure TTGs, that do not have a modern counterpart, suggesting some uniquely Archaean petrogenetic process, involving deep (> 15—20 kbar) melting of metamafic rocks.

The differences between Archaean and modern granitoids reflects similar differences observed in mafic rocks: Archaean mafics lack the clear dichotomy observed in the modern record between arc and non-arc samples; and do not show any evidence for strongly depleted or enriched mantle sources. Likewise, Archaean granites reveal a tectonic system with a near-primitive mantle; more common melting of oceanic plateaus; some continental collision; deep melting of mafic rocks, with no modern equivalent; and lacking modern-style subductions (with water fluxed melting of the mantle wedge), although some rocks record melting of a mantle enriched by buried surface matter.

Applications of Absorption Spectroscopy for Water Isotopic Measurements in Cold Clouds

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While mass spectrometry has been the measurement technique of choice for environmental water isotopic studies, absorption spectroscopy is becoming increasingly competitive for many applications. Advances in instrument sensitivity allow extending the use of isotopic measurements beyond tracing large-scale water transport, an application with relatively loose measurement requirements, to microphysics studies in cirrus and convective clouds in the dry upper troposphere. We outline measurement requirements for science applications in cold cirrus clouds, describe the development of isotopic instrumentation for microphysics studies at the AIDA aerosol and cloud chamber, and present isotopic measurements from the 2012-2013 ISOCLOUD campaign. ISOCLOUD adiabatic expansion experiments from 233-190 K produced the first direct measurements of isotopic fractionation factors at temperatures applicable to cirrus clouds and suggest the feasibility of field studies using water isotopologues as microphysical tracers.

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