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Propylitization 1865–2020: Historical Perspective and New Paradigm for the Origin of Propylitic Alteration in Porphyry Systems

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The first recorded use of the term "propylite" by Ferdinand von Richthofen in 1865 was applied to greenish porphyritic rocks with chlorite and epidote surrounding the Comstock intermediate sulfidation lode, Nevada. The term came from the Classical Greek "propylon," meaning "gateway," because von Richthofen believed these rocks were a unit at the stratigraphic base (i.e., gate) of the Tertiary stratigraphy. It was subsequently realised that they were simply chlorite-, epidote-, and calcite-altered andesites and diorites, directly associated with mineralization. In tandem with the development of the concept of hydrothermal alteration came the understanding that metal zonation also existed around magmatic-hydrothermal deposits, extending well into the propylitic domain (e.g., Emmons, 1927). Until the 1950s, the term "propylitic" was just used for andesitic protoliths, but once the widespread occurrence of the alteration type was recognised in a variety of ore systems, the term was broadened to refer to a hydrothermal alteration assemblage of epidote, chlorite, albite, and calcite, often with pyrite, in any original lithology. Propylitic alteration was given a theoretical foundation by the seminal work of Meyer and Hemley in 1964, but at this point, a classification dichotomy developed in which the term propylitic was applied either broadly to rocks containing the typical mineral assemblages of the alteration type, or just to the weak, mainly isochemical, subset of these assemblages. The view that propylitic alteration is essentially an isochemical process apart from limited hydrogen metasomatism, hydration, and the addition of minor carbonate and sulfide, has since become entrenched in the literature.

The "modern" era of propylitic research in porphyry systems began in the 1980s with the visionary Ph.D. thesis of the "father" of propylitic alteration, Geoff Ballantyne (University of Utah). He studied Silver Bell, Safford, and Christmas in southern Arizona and derived the essential characteristics of propylitic alteration that we are really just refining with the benefit of modern technologies today. His work recognized the diverse mineralogy that exists, constrained temperatures of formation and the gradational relationship with potassic alteration, and implicated a magmatic fluid contribution using oxygen isotopes. Later stable isotope studies in the 1980s-1990s appear to have been influenced by the emerging view at the time that meteoric waters were predominant in intrusion-centred hydrothermal systems. The inferred dominance of groundwater as a driver of propylitic alteration remains a majority opinion even today.

However, recent studies, including the AMIRA-funded series of projects led from CODES at the University of Tasmania, have begun to change this paradigm. Increasingly, significant chemical mass transfer is recognized in the propylitic zone of porphyry deposits, consistent with the earlier findings of Emmons, and addition of magmatic components is supported by detailed isotopic analysis of propylitic mineral separates from the Northparkes system, New South Wales. Thus, there is an emerging view that magmatic fluids are pervasive throughout this domain, helping to account for the extensive trace element dispersion patterns now recognised in the major propylitic minerals, epidote and chlorite, that are being developed as powerful exploration tools for porphyry deposits under cover.