

An empirical method for estimating instream pre-mining pH and dissolved Cu concentration in catchments with acidic drainage and ferricrete

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An empirical method is proposed for assessing background water quality of streams affected by historical mining. Stream-specific equations were generated from relations between either pH or dissolved Cu concentration in stream water and the Fe/Cu concentration ratios in Fe-precipitates presently forming in three acidic streams in Montana, USA. The equations and Fe/Cu ratios for pre-mining deposits of alluvial ferricrete along each stream then were used to reconstruct estimated longitudinal profiles of pre-mining pH and dissolved Cu concentration. The method assumes that alluvial ferricretes and modern Fe-precipitates share a common origin and that the Cu content of Fe-precipitates remains constant during and after conversion to ferricrete. The method was evaluated by applying it in a fourth, naturally acidic stream unaffected by mining, where estimated pre-mining pH and Cu concentrations were similar to present-day values and by demonstrating that inflows from unmined areas had consistent effects on both the pre-mining and measured profiles of pH and Cu concentration. Using this method, it was estimated that mining has affected about 0.5 m of Daisy Creek, 1.8 km of Fisher Creek, and at least 1 km of Swift Gulch. Estimated pre-mining pH values were ~0.6 units higher in Daisy Creek, 1-1.5 units higher in Fisher Creek, and 1.3-1.9 units higher in Swift Gulch. Estimated pre-mining dissolved Cu concentrations were almost 40% lower in Daisy Creek and as much as 70% lower in Fisher Creek. Uncertainty in the fate of Cu during this conversion translates to potential errors in pre-mining estimates of as much as 0.25 units for pH and 22% for dissolved Cu concentration.

Planetary differentiation timescales: Insights from physics and chemistry

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Introduction

Planetary differentiation involves the delivery of mass and energy, resulting in chemically distinct reservoirs (e.g. crust, core). The formation of these reservoirs provides important geochemical constraints on the timescales and physical processes involved. Here I will discuss two such processes: core formation and magma ocean evolution.

Planetary accretion is rapid: ~1 Myr to build Mars-sized bodies, ~10-100 Myr to finish assembling Earth-sized bodies [1]. Rapidly-formed small bodies are heated primarily by decay of short-lived radioisotopes, which leave behind detectable signatures [2]. Large (Earth-sized) bodies are heated mainly by individual late-stage impacts [3]. Mars-sized bodies are gravitationally heated to an extent determined by the size-spectrum of the impacting bodies [4].

Core Formation

For large bodies, core formation is the result of individual collisions. Depending on the timing of and degree of equilibration during these collisions, measurable ¹⁸²W anomalies will develop [5]. Forward modelling of these processes [6] is hampered by uncertainties in how equilibration and partitioning vary with time [7-8]. Even so, the inferred core formation timescales agree roughly with those predicted from accretion simulations [5, 6].

Less work has been done on core formation of small bodies. Drainage of iron to the core is possible once iron melting begins, and very rapid once silicate melting occurs [9]. Early melting due to radioactive heating should lead to predictable (and testable) correlations between indicators of core formation (e.g. ¹⁸²W or ¹⁰⁷Ag) and of heating (e.g. ²⁶Mg).

Magma Ocean Evolution

Large impacts create regional or global magma oceans [3]. Arguments based on siderophile abundances can only be used to constrain time-averaged magma ocean *P,T* values [10]. Modelling magma ocean duration is complicated because of the uncertain roles of a potentially buoyant crust and/or thick atmosphere. Early Martian isotopic heterogeneities are preserved, suggesting long-lived magma ocean(s) and little convective mixing [11].

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