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Novel geochemical techniques integrated in exploration for uranium deposits at depth

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Mineral deposits are in fact geochemical anomalies, and as such their detection and assessment of their impact on the environment should be facilitated using geochemical techniques. Although geochemistry has been used directly in the discovery of uranium deposits and more indirectly in shaping deposit models, the novel applications of geochemistry and integration with other data can be more effective in formulating exploration and remediation strategies. Recent research on the use of geochemistry in detecting uranium deposits at depth include: (1) more effective integration of geochemical with geophysical data to refine targets, (2) revealing element distributions in and around deposits to adequately assess the total chemical environment associated with the deposit, (3) the use of element tracing using elemental concentrations and isotopic compositions in the near surface environment to detect specific components that have migrated to the surface from uranium deposits at depth, (4) understand the effects of both macro- and micro-environments on element mobility across the geosphere-biosphere interface to enhance exploration using select media for uranium at depth. Geophysical data used in exploration can identify areas of conductors where redox contrasts may host mineralization, structures that act to focus fluids during formation of the deposits and act as conduits for element migration to the surface, and contrasts in geology that are required for the deposits. However, precision of these data is greatly diminished with depth, but geochemical data from drill core or surface media can enhance target identification when integrated with geophysical data.

Geochemical orientation surveys over known unconformity-related deposits at depth clearly identify mineralization 900m deep. Drill core near the deposit, clay-size fractions separated from soil horizons and vegetation over and far from the deposit record element migration from the deposit as radiogenic He, Rn and Pb unique to uranium-rich sources. Isotopic compositions of C and N indicate microbial interactions with the uranium deposits, which is the likely process by which elements are mobilized out of the deposits and into the surrounding environment for us to use as vectors to ore. Correlations among pathfinder elements occur in fractures in core, but also in various surface media. Multi-element analyses including Pb isotopes of the clay-sized fractions of all soil horizons and vegetation provide compelling evidence that a robust geochemical signature exists. All of the processes that operate to produce geochemical anomalies at the surface above unconformity-related deposits are applicable to all other types of uranium deposits and should be integrated into learning curves for effective exploration of uranium.

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