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The Origin of Uraninite, Bitumen Nodules, and Carbon Seams in Witwatersrand Gold-Uranium-Pyrite Ore Deposits, Based on a Permo-Triassic Analogue

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Abstract

Permo-Triassic Dongara sandstones from the Perth basin of Western Australia contain solitary bitumen nodules that are analogous to uraniferous bitumen nodules (or fly-speck carbon) in Late Archean Witwatersrand gold-uranium-pyrite ore deposits. Nodules in both contain cores of radioactive minerals and occupy depositional sites where heavy minerals were concentrated. Solitary bitumen nodules in the Dongara Sandstone formed during burial by radiation-induced polymerization of liquid hydrocarbons migrating through primary porosity around detrital monazite grains. Similar bitumen nodules in Witwatersrand ore deposits are likewise interpreted to have formed during burial, although the radiation-emitting detrital grains were uraninite.

Carbon seams in Witwatersrand ore deposits are stratiform bodies of coalesced bitumen nodules. By analogy with solitary nodules, individual nodules in carbon seams formed during burial as liquid hydrocarbons migrated through primary porosity past detrital uraninite grains, but they differ from solitary nodules in that many have been stretched perpendicular to bedding to form an ellipsoidal or columnar structure. Although a columnar structure is consistent with deformation by vertical extension, that deformation clearly postdated nodule formation. In some seams, elongated nodules are associated spatially with framework-hosted bedding-parallel microfractures, which are commonly filled with fibrous secondary minerals. Again, bedding-parallel microfracturing clearly postdated nodule formation. Columnar-textured bitumen and bedding-parallel fractures are interpreted to be postdiagenetic structural fabrics, whereas carbon seams appear to have been a microfocus of a compressive deformation. Neither columnar-textured bitumen nor bedding-parallel fractures are present in the Dongara Sandstone, and they are not present in every Witwatersrand carbon seam either, supporting the contention that columnar-textured bitumen and bedding-parallel fractures are focused structural fabrics that postdate nodule formation.

Recognition that solitary bitumen nodules and carbon seam hosted bitumen nodules of Witwatersrand ore deposits are analogous in origin to bitumen nodules in the Dongara Sandstone, supports historical mineralogical observations that the Witwatersrand basin contained uraninite placers. Indeed, carbon seams are most likely the former sites of heavy mineral uraninite strands. Given the chemical instability of uraninite under oxidizing conditions, detrital uraninite in Witwatersrand strata supports the long-held contention that the Archean atmosphere contained significantly less oxygen than the modern atmosphere.