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Some Speculations on the Development of Central Wyoming as a Uranium Province

The Wyoming Uranium Province was generated during Proterozoic time (1,700-1,400 million years ago) as the result of a thermal metamorphic event possibly associated with the collision of continental plates and the overriding of the northern plate by the southern. This event remobilized uranium contained in Archean granitic rocks (2,400-2,600 million years old) and drove it to crystallographic locations favorable for leaching and may have also developed a crude layering with the more uranium-enriched rocks in a higher position. Weathering and erosion of the Precambrian rocks took place from late Precambrian through early Paleozoic until the Precambrian was buried. The development of the current structure in Wyoming during the Laramide orogeny with the formation of the basins and ranges brought the altered Precambrian granites back to the surface by late Paleocene — early Eocene time. During Eocene through Oligocene time, several coincident factors were instrumental in the formation of the major sedimentary uranium districts of central Wyoming:

1. The recently deposited sediments were still unconsolidated, very porous, and permeable. Organic matter deposited with the sediment resulted in reduced sediments shortly after deposition.
2. Rainfall was high and the climate was subtropical to savannah changing to warm temperate during Oligocene.
3. The Precambrian rocks in the core of the ranges were fully exposed and being deeply weathered and eroded.
4. Volcanism began in the Yellowstone-Absaroka region depositing layers of airborne ash across the ranges and basins.

The volcanic ash, when flushed by the first rainfall, produced a unique fluid which was acidic and charged with ions. The chemical reaction of the buffering of this fluid on contact with the Precambrian granites, the ash itself, and other rocks, brought the pH back to approximately neutral but leached additional uranium from the granites and probably the ash. The high rainfall and climate assured a steady supply of dissolved oxygen to the fluid resulting in the formation of a unique, oxidizing, uranium-enriched fluid which entered the unconsolidated, reduced sediments oxidizing them and carrying the uranium to the eventual maximum extent of oxidation. This ore-forming fluid was regenerated after each new ash fall from mid-Eocene through possibly mid-Oligocene. The young unconsolidated sediments of the basin

could readily accept large volumes of the continually regenerating ore-forming fluid. Fluid flow through the very porous and permeable sediments would be relatively fast allowing for the development of large oxidized tongues within the young sediment as well as scattered uranium deposits at the redox interface within approximately one million years. Deposits formed near the granitic highlands would be larger and of higher average grade because of the proximity to the dual source of granite and ash. Those deposits formed farther basinward were formed from fluids which were diluted from the dual source or were derived solely from the uranium from the ash causing them to be smaller and of lower grade. These deposits were formed starting over 40 million years ago with the major period of mineralization between 35 and 24 million years ago. The deposits were relatively well fixed in place at the completion of the mineralizing period and have undergone minor modifications since that time as long as they continued to be below the water table. Those deposits which were brought to positions above the water table and within the range of erosion were severely modified and often totally destroyed. Fractured and karstic limestones, organic shales, peat bogs, and any other porous and permeable rocks exposed at the surface during this time would be exposed to the ore-forming fluids generated in various areas at various times from different ash falls and could have had deposits form in them. The inability of most of these other environments to accept major fluid flow would assure that their deposits would generally be smaller and of lower grade.

This concept of formation of the Wyoming Uranium Province appears to be compatible with currently available data as well as providing explanations for the wide variety of uranium deposits and occurrences in the State. It is felt that this concept can be applied totally, in part, or with modifications to most of the major uranium provinces of the world to help explain the occurrence and distribution of uranium deposits. The development of this concept accentuates the importance of a region as related to mineral exploration. The use of deposit models in exploration often tends to be a short-sighted approach while a concept-of-genesis approach to exploration reveals many potential targets which may be very diverse but related by genesis.