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BRECCIA BODIES IN THE CARLIN TREND, ELKO AND EUREKA COUNTIES, NEVADA: CLASSIFICATION, INTERPRETATION AND ROLES IN ORE FORMATION

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ABSTRACT

Breccia bodies played a critical role in deposition of an estimated 70 million ounce gold resource in the Carlin trend. Combinations of sedimentary debris flow, collapse, fault and fluidized hydrothermal breccias aided in the formation of all Carlin trend deposits.

Carbonate host rocks in the Carlin trend contain stacked debris flow breccia packages. Debris flow breccia characteristics include bedding conformability, scoured bases and planar tops, fining up sequences, heterolithic matrix-supported clasts, and the presence of stylolites cutting fragments and matrix. Debris flows are capable of initiating and moving hundreds of kilometers on slopes as low as 1°. The resultant debris flow packages act as preferred hosts to gold mineralization because they are more susceptible to decarbonatization (which greatly increases permeability).

Pre- and/or post-ore collapse breccias occur in almost all Carlin trend gold deposits. Collapse breccias are associated with decarbonatized rock and characterized by blocky contacts, delicate angular fragments, downward fragment transport, a high percentage of fragments, and overlying intensely fractured rocks. Collapse breccias form when hydrothermal fluids remove carbonate from sediments, resulting in volume loss and simultaneous spalling of rock into developing voids. Pre-ore collapse breccias played a critical role in the formation of large Carlin trend gold deposits, including Gold Quarry and Post. Formation of collapse breccia by early hydrothermal fluids has two critical consequences. First, collapse breccias and associated decarbonatized rocks remain highly permeable, allowing migration of large volumes of gold-bearing fluids. Second, the decarbonatization and collapse process may result in structural preparation of overlying units due to 40-60% volume loss at depth. Such volume loss could result in deposit-scale collapse, allowing the formation of overlying orebodies hosted in intensely fractured impermeable clastic sediments (such as the Gold Quarry Main and the Upper Post ore zones).

Fault breccias are a key component in all Carlin trend gold deposits. They have tabular geometries, gouge, slickensides, and distinct textural zonation from the edges in. Fault breccia zones served as fluid conduits, allowing gold bearing solutions to reach host rocks.

A favorable combination of these first three breccia types occurs in the Lower Post orebody (Fig. 1). A sequence of stacked carbonate debris flows and calcarenites hosts the Lower Post. The debris flow breccias were more susceptible to early (pre-ore) carbonate removal than adjacent rocks and were therefore overprinted by collapse breccias. Permeable collapse breccias and associated decarbonatized rock formed an ideal host for gold deposition. Hydrothermal fluids reached the prepared host rock by moving upward along permeable fault breccias. The removal of carbonate at depth and subsequent volume loss and collapse may also have resulted in structural preparation of clastic sediments in the Upper Post deposit.

The fourth Carlin trend breccia type is fluidized hydrothermal breccia. The only hydrothermal breccia observed in the Carlin trend hosts the Rain deposit (Fig. 2). The Rain hydrothermal breccia is associated with crackle breccia, accretionary lapilli pipes and hydrothermally fractured rock. Diagnostic characteristics include irregular scoured contacts, flow banding, and a high percentage of rock flour matrix. The hydrothermal breccia formed by repeated fluidization and convective milling of fragments during multiple boiling events. The absence of fluidized hydrothermal breccias in the northern Carlin trend suggests a greater depth of formation (> 1 km) below which lithostatic load was too great for fluidization to occur. In addition to hydrothermal breccia, the Rain deposit contains fault and collapse breccias (Fig. 2). Fault breccias allowed hydrothermal fluids access to permeable structurally prepared host rocks in the hanging wall of the Rain fault zone. Collapse breccias are present at the limestone contact under the hydrothermal breccia. The post-ore collapse breccias developed when acidic supergene fluids dissolved limestone below the hydrothermal breccia. Supergene fluids also resulted in oxidation and intense advanced argillic alteration of the hydrothermal breccia and concentration of leached elements at the buffered limestone contact.

Breccias formed by different processes may share similar characteristics, making identification of breccia types based on single hand samples difficult. It is therefore essential to look at all aspects of a breccia, especially geometry and the nature of contacts with host rocks, before speculating about its origin. When correctly identified, breccia bodies provide critical information about the genesis of orebodies and an additional tool for gold exploration.

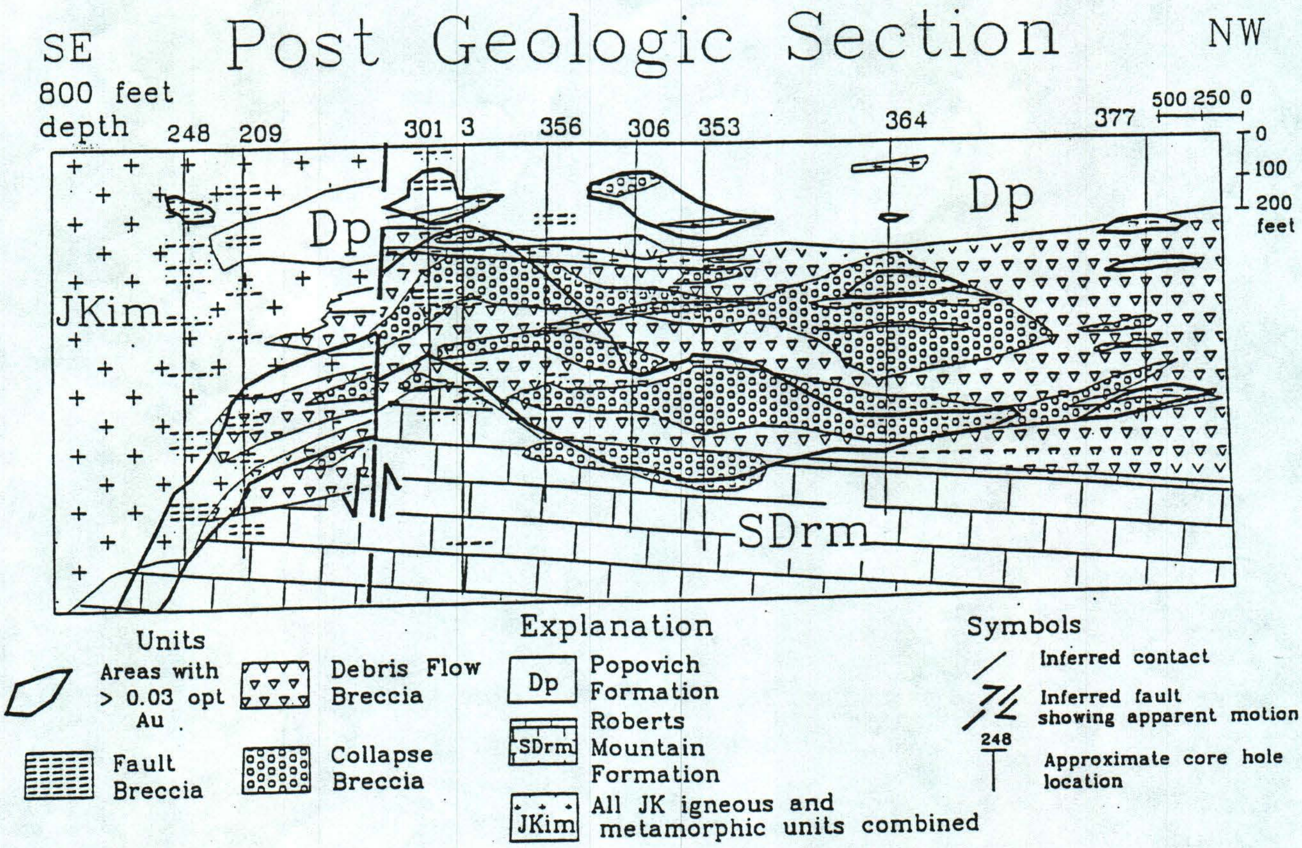

Figure 1. Geologic cross section of the Lower Post showing fault, debris flow and collapse breccias, and the distribution of gold. Contacts are inferred from drill core information.

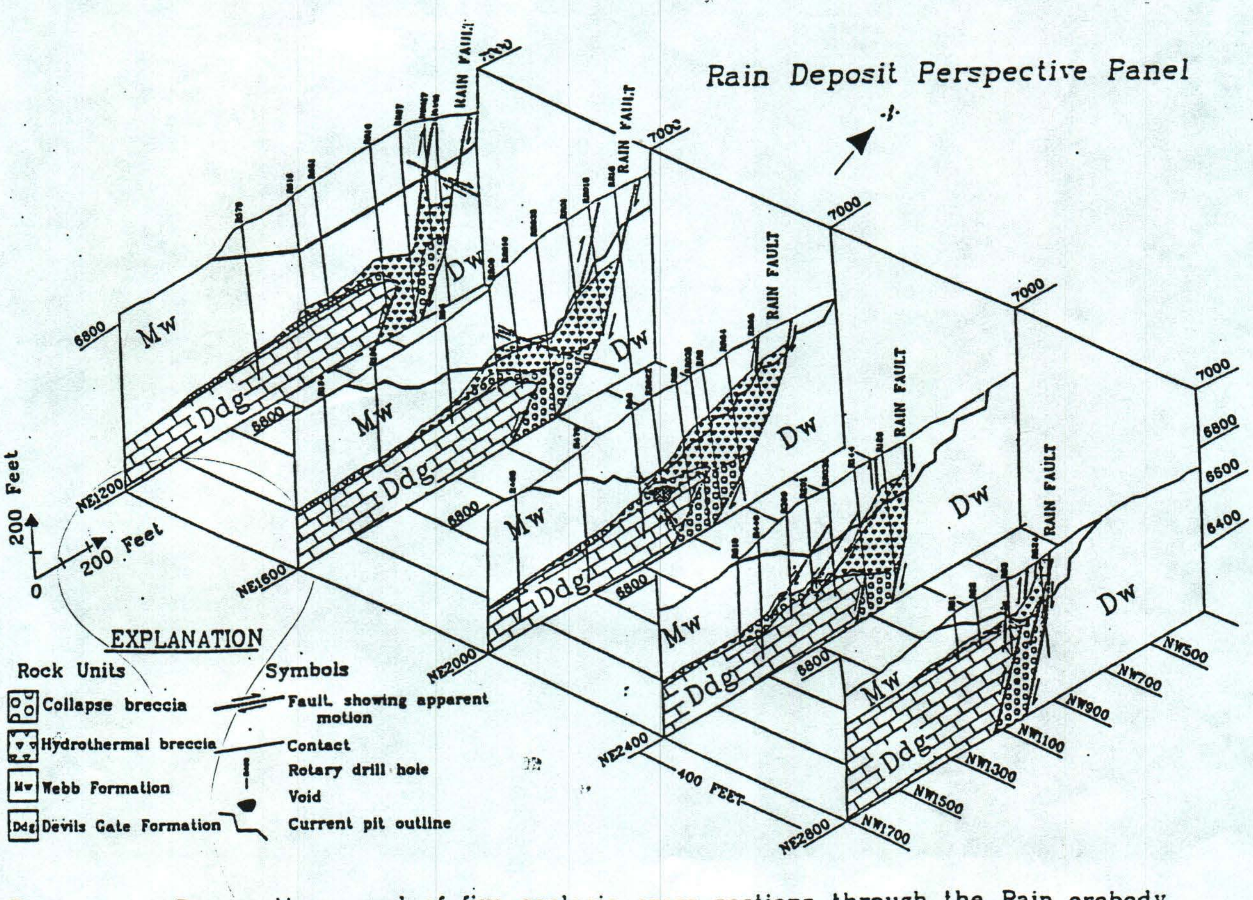

Figure 2. Perspective panel of five geologic cross sections through the Rain orebody. The panel is based on surface exposures and data from 36 rotary drill holes.