

Genesis of precious opal in the Critical zone: role of the host rock, climate, and biology

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Most deposits of precious opal (i.e., with play-of-color) occur within continentally weathered rocks. This is the case in Australia, Ethiopia, Canada, Brazil, Indonesia and most western USA deposits. A review of published data and our own investigation shows that all of these deposits are embedded in volcanoclastic sediments (strongly re-worked in Australia), virtually all without carbonates. Depending on the deposit, the mineralization in opal occurred through the weathering of volcanic glass and/or feldspars into clays (the montmorillonite smectite), or through the weathering of smectite into kaolinite, all these reactions releasing silica. Volcanic glass is very widespread over the continents, and weathering occurs almost everywhere. This is why common opal is so abundant, although discreet. However, the precious variety of opal is very uncommon. Hence, a specific set of geological conditions rarely encountered together is required for precious opal to form, and to remain preserved up to now.

Opal formed few meter below the paleosurface in some cases (Ethiopia [1]), sometimes much deeper (down to 40 meters in Australia [2]). The role of pedogenesis in opal formation is sometimes striking (Ethiopian opals contain rootlet fossils), sometimes more subtle: silica can migrate vertically down to unweathered levels and precipitate into cavities. This occurred for some opals from Ethiopia (Mezezo), Canada and most probably Western American deposits.

Field evidences suggest a climate wet enough to strengthen the weathering process. This also favored the development of an important vegetal cover, but the role of organisms (plants, bacteria) in precious opal formation remains unclear.

[1] Rondeau *et al* (2012) *GEEA*, **12**, 93-104. [2] Rey (2013) *Aust. J. Earth Sc.* **60** (3) 291-314.