

Beyond 3d ions: gems colored by uranium and sulfides

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If 3d ions are a common source of absorption in gems, including some of the most valuable ones (ruby, emerald and sapphire), they are far from being the only one. If color centers bring a tint to diamonds, rarer gems may offer surprises. Here we concentrate on two recently studied odd gems: hyalite opal from Mexico and “Bumble Bee Stone” (BBS) from Indonesia.

Green daylight fluorescing hyalite opal has been discovered in the state of Zacatecas, Mexico. It occurs along fractures and cavities in a poorly-welded rhyolitic tuff as centimetre-thick botryoidal coatings that locally cover a series of uranium minerals. The faceted material shows a spectacular change of color phenomenon, going from near-colourless or yellow in incandescent light, to a bright green in indirect sunlight. The daylight-induced green luminescence is related to the presence of the uranyl molecule (UO₂)²⁺. The hyalite opal is not porous and contains approximately 2.7 % H₂O, which is remarkably low among gem opals. If a similar green shortwave-ultraviolet induced luminescence in “common” opals is often seen, a daylight induced one is of great rarity. It is due in part to the lack of iron (Fe³⁺), the most common UV-absorber in gems.

“Bumble Bee Stone” is a bright yellow and black decorative stone, hence its name. Also incorrectly named “mustard jasper”, it is a carbonate rock, thus, not a jasper (a silica-based gem). It comes from a vein of sulfides at the base of an Indonesian volcano, in the west of the island of Java. Its most remarkable characteristic is its bright yellow color, which is caused by inclusions of an unexpected sulfide, pararealgar, not orpiment. This was unambiguously established via Raman scattering. The orange color seen sometimes is a mix of the red of realgar with the yellow of pararealgar. Both minerals are polymorphs of As₄S₄, arsenic tetrasulfide. Black is due to micron-size pyrite crystals, of the framboid variety. The successive growth layers, when cut through in different orientations, give rise to a variety of eye-catching patterns.