GeoSpectra Scientific Consulting
19174 Torrejóndel Rey,
Guadalajara (Spain)
+34-949 327 918/646 321 775
www.geospectra.es
laboratorio@geospectra.es

SUMMARY OF STUDY OF FLUORESCENT HYALITE OPAL

Sample: JF1402202

Requested by FMinerals

Description:

Specimenof greenish hyalite opal on matrix from Mexico. Opal exhibit a strong yellow-green fluorescence suggesting the presence of uranyl (UO_2^{2+}). Sample submitted to uranium presence confirmation.

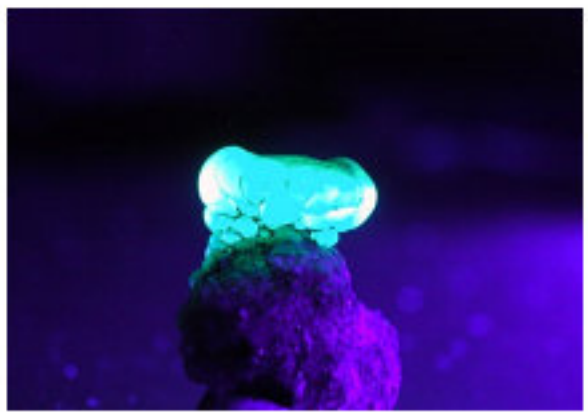

Figure 1: Opal specimen under 370 nm UV light, showing green fluorescence emission.

Results and Discussion:

The opals are formed by weathering of silicic rocks (volcanic or sedimentary) and subsequent precipitation in the form of gels in SiO_2 enriched water, or by amorphous silica precipitation in silica saturated hydrothermal solutions (150ºC-200ºC). Under the conditions of formation of opal, impurities as Al, Fe, Mg and Ca are frequent in significant quantities. The more common trace elements (concentrations below 500 ppm), are uranium, barium, niobium, strontium, manganese and titanium. About luminescent opals, it has been recognised two main types of fluorescence: the green fluorescence, attributed to uranyl, and the blue fluorescence, attributed to intrinsic non- bridging oxygen defects in the silica structure (Gaillou et al., 2007).

Uranium is common in opals, as it is incorporated to the silica-gel precipitates in the form of co-precipitated uranyl silicates. It is noteworthy to mention that the fluorescence or colour intensity of opal does not have a dependence relationship with the uranyl concentration. In order to non-destructively identify and evaluate the uranyl content in the sample, we performed the gamma spectrometry study. The

NaI(Tl)-gamma spectrum of the sample (Figure 2) shows the characteristic profile of naturally occurring uranium in secular equilibrium (age>$7x10^5$ years). To estimate the order of magnitudeof uranium concentration, we calibrated the spectrometer using glass beads with known uranium content and maintaining the geometry of the system. The calibration shows a U concentration in the sample of ~ 1000 ppm. For practical comparison, the radioactivity associated is detected only by sensitive instruments and the uranium content of the sample is approximately equivalent to an autunite plate of 1 x 1 x 0.02 mm. Take into account that this uranium content is only order estimation. Destructive techniques, as ICP-MS, should be used to determine the uranium concentration.

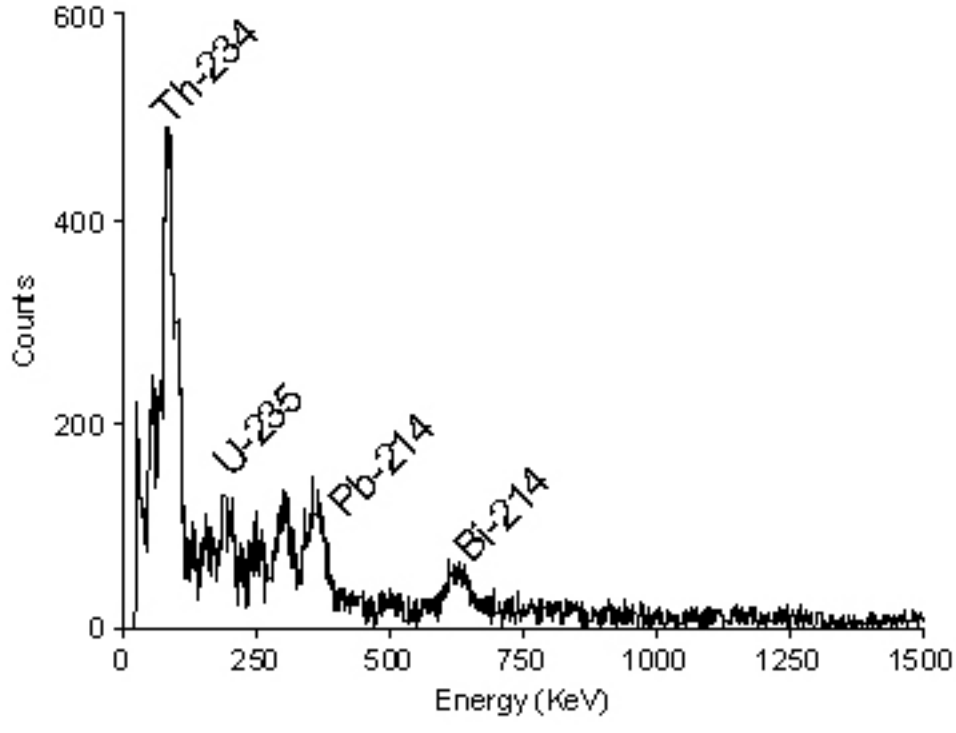

Figure 2: NaI(Tl)-Gamma spectrum of the green fluorescent opal sample, showing the emission peaks ofisotopes of natural uranium decay series.

The gamma spectrum of the sample confirms the presence of uranium. To asset the chemical form of uranium in opal, we performed the Raman spectrometry study of the opal (Figure 3)

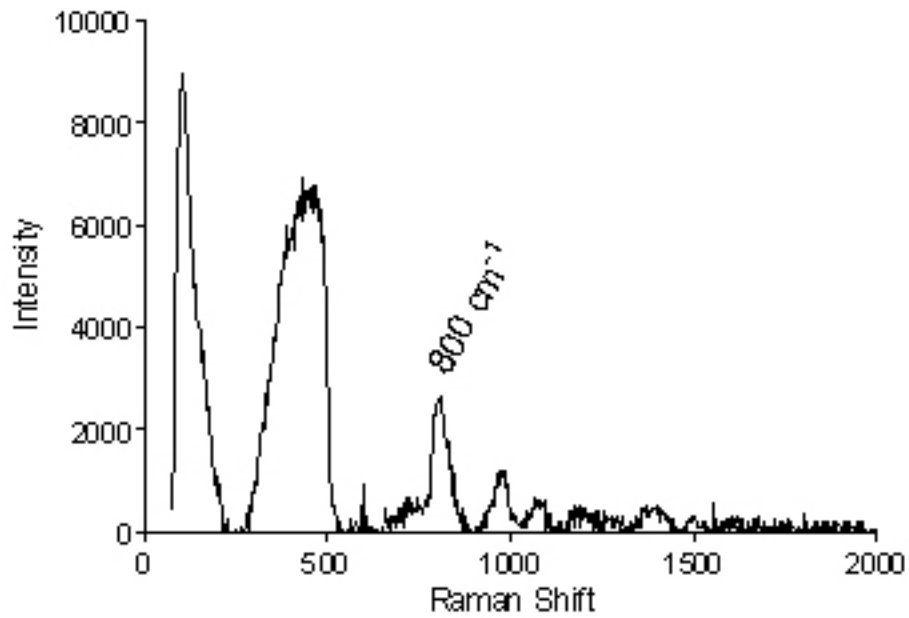

Figure 3: Filtered Raman spectrum of green fluorescent opal sample, showing the main contributions to the Raman scattering of opal: amorphous silica and cristobalite.

Overall, the spectrum shows high degree of disorder, with dominance of amorphous material. . Opal has not a unique or distinctive structure. Instead, is a material with high degree of structural disorder with diverse crystallinity grade and contributions of disordered cristobalite+tridymite (Opal-CT) or microcrystalline cristobalite (Opal-C).The sample shows a broad signal centered around 460 cm^{-1}, typical of amorphous silica, and a cristobalite band at lower shift.

The other secondary visible bands correspond to the Si-O or Si-OH vibrations. The band centered at 800 cm^{-1} is characteristic and useful in the opal indexation, as it is indicative of low temperature opals, usually, but not necessarily, sedimentary (Figure 4).

The second derivative of the filtered signal shows a contribution at 882 cm^{-1} that constitutes an anomalous signal in the deconvolution of Si-O vibrations that gives it shape to the 800 cm^{-1} band. This contribution is attributable to the signal of uranyl (UO_2^{2+}), confirming the gamma spectroscopic data and possibly explaining the strong fluorescence of the sample.

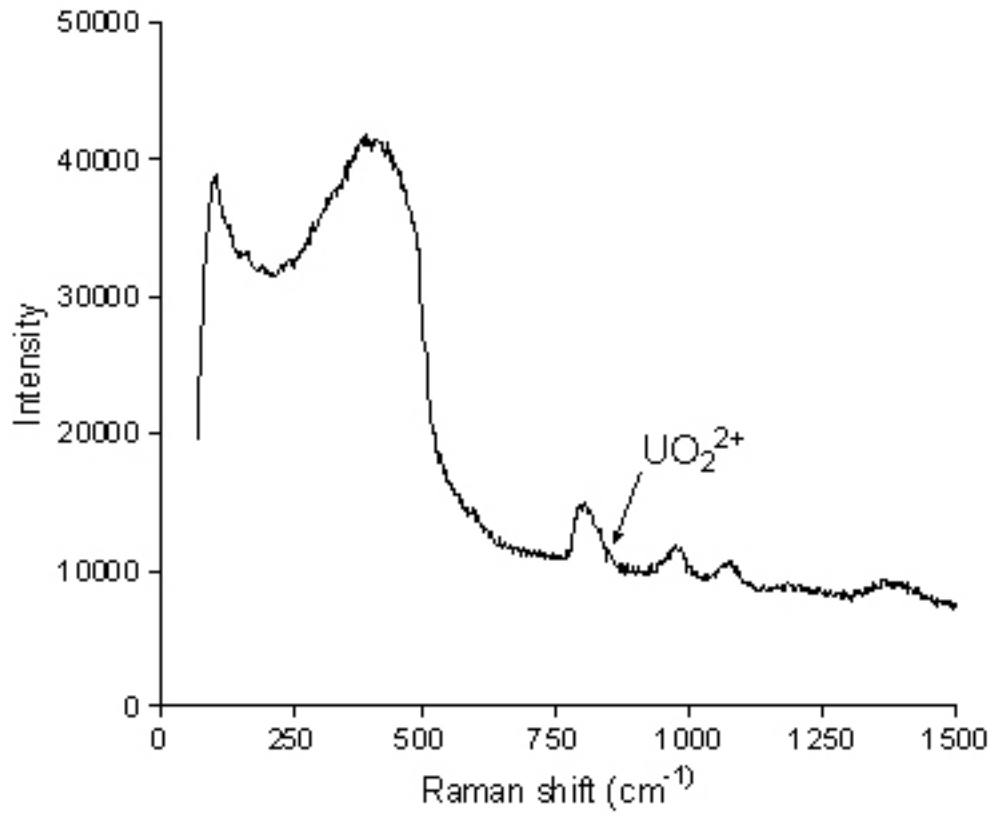

Figure 4: Raman spectrum of opal sample, showing the characteristic profile of opals of low temperature formation. A weak uranyl peak were found, revealed by derivation and deconvolution of Raman signal.

Conclusions:

The spectroscopic study of opal sample suggests that is an uraniferous opal formed by low temperature process (sedimentary or very low temperature hydrothermal). The presence of uranyl could explain the strong green fluorescence of the sample. The study of the fluorescence spectrum should confirm this observation.The precise determination of trace elements (by ICP-MS, for example) could be useful in the explanation of opal properties and in the study (age) of deposit.

References:

Gaillou, E., Delaunay, A., Rondeau, B., Bouhnik-le-Coz, M., Fritsch, E., Cornen, G., &Monnier, C. (2008).The geochemistry of gem opals as evidence of their origin.*Ore GeologyReviews*, *34*(1-2), 113–126.

Ilieva, a., Mihailova, B., Tsintsov, Z., &Petrov, O. (2007). Structural state of microcrystalline opals: A Raman spectroscopic study. *American Mineralogist*, *92*(8-9), 1325–1333.

Guadalajara (Spain), at Wednesday, February 23, 2014

César MenorSalván, PhD

Analytical Chemist and Mineralogist