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# Opal instability: a relationship between water and microstructure?

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Unlike other gem minerals, opals can suffer a change in their quality with time, resulting in a lack of confidence and hence marketability of this gemstone. The instability has been described and categorized into 2 main types (Aguilar et al., 2004; Aguilar-Reyes et al., 2005; Rondeau et al., 2011): cracking (development of a network of micro-fractures) and whitening (decrease of transparency). Available literature about opal instability, however, is restricted to its description. Although the process involved in the destabilization remains poorly understood, it has been proved, in at least one instance, to be associated with the release of water and a change of its speciation (Pearson, 1985; Paris et al, 2007). We propose 3 models to explain the cracking and/or whitening: (i) drying shrinkage of microstructural units, (ii) differential partial pressure between water enclosed in the opal and atmosphere and (iii) release of water yielding empty pores resulting in a strong light-scattering and hence opacity. In order to ascertain the model, a comprehensive set of opals from various origin and structure have been selected for investigation base on previous heating experiments which identified samples with a high susceptibility to crack or whiten. These samples will be investigated to identify the origins of the destabilization phenomena using infrared spectroscopy (FTIR), thermal analysis (gravimetric (TG) and calorimetric (DSC)) and gas adsorption measurements. FTIR will allow the main species of water present in opals (molecular water and hydroxyl groups) and their proportion to be determined while TG will be used to accurately determine the total water content. Gas adsorption and thermoporosity (DSC) will be used to characterize the porosity (surface area, pore size and crystallizable water content). The characterization of water and microstructure for each opal may provide the potential link between the mobility of water in the microstructure and the observed instability. The identification of the main factors controlling the destabilization will lead to the development of a non-destructive method for the categorization of gem-stability, increasing confidence in this gemstone for dealers, cutters and the consumer.

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