A new paleothermometer for evaporitic halite : Brillouin spectroscopy

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The reconstruction of changes in Sea and Lake Surface Temperatures (SST and LST, respectively) is critical for our knowledge of past climatic changes. Most of these reconstructions are based on bio and or geochemical proxies. In ancient evaporitic basins however, where proxies based on fossil life are unusable, microthermometry on subsurface minerals fluid inclusions (FIs) appears to be the most adequate paleothermometry alternative. FIs are present in virtually all rock minerals, including halite - a major constituent of evaporitic series -, and are commonly used to constrain Formation Temperature (Tf) of crystals, via the microthermometry technique. This approach assumes that the vapor bubbles contained in biphasic FIs disappear, during heating, at a given Homogenization Temperature (Th) corresponding to the FI Tf. Halite samples generally contain monophasic FIs, hence they are cooled in a freezer to nucleate a vapor bubble in the FIs, prior to gradually heating them to reach the Th. Although this technique is widely used, it also faces several limitations, namely:

1. The unpredictability and scarcity of bubble nucleation. Indeed, only a small fraction of FIs show bubble nucleation upon cooling.
2. The observed values of Th in a single sample form a broad distribution, covering a wide temperature range ; this may be due to damages caused by cooling

The latter is the main limitation of the microthermometry approach. Conflicting views about the true formation temperature are found in the literature : some authors recommend to use the mean of the Th distribution [1], others its maximum [2].
We have used FIs in synthetic and semi-natural halites to demonstrate the potential of a novel technique, Brillouin spectroscopy, in determining the formation temperature of fluid inclusions in evaporites. The main asset of this new method is that it is free from the above limitations because it does not depend on the formation of vapor bubbles [3]. The use of both Brillouin and microthermometry techniques on the same samples of synthetic halites has confirmed the advantage of Brillouin spectroscopy and its extended use on natural evaporites. Indeed, in contrast to microthermometry, the Brillouin technique gives a narrow distribution of Tf values (± 3°C), consistent with the known precipitation temperatures of the synthetic and natural samples. Brillouin spectroscopy thus provides a unique tool for SST and LST reconstructions in evaporitic sequences.

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