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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 fossil life is unable to provide any temperature proxy as it is virtually absent, microthermometry on fluid inclusions appears to be the most adequate paleothermometer alternative. Fluid inclusions (FIs) are present in virtually all rock minerals, including halite, and are commonly used to constrain formation temperature of crystals, via the microthermometry technique. This approach assumes that the vapour bubbles contained in FIs disappear, during heating, at a given homogenization temperature Th corresponding to the FI formation temperature. Samples are cooled in a freezer to nucleate a vapour 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 samples can be damaged by thermal treatment, as shown by the change in Th for the same FI after several cooling-heating cycles.
3. The observed values of Th in a single sample form a broad distribution, covering a wide temperature range.
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, others its maximum.
We have used FIs in synthetic 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 vapour bubbles. The application of these two techniques to the same samples of synthetic halites has confirmed the advantage of Brillouin spectroscopy and its usage on natural evaporites. Indeed, in contrast to microthermometry, the Brillouin technique gives a narrow distribution of Th values, consistent with the known precipitation temperatures of the synthetic samples. Brillouin spectroscopy thus provides a unique tool for SST and LST reconstructions in evaporitic sequences.