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# Brittle deformation history and paleofluid system of the Mirabeau anticline, Provence fold-and-thrust-belt.

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## Résumé

Folded rocks commonly display brittle mesostructures that accommodate contraction and impact fluid flows in reservoirs. In the Mirabeau anticline (SE France), we report the sequence of development of several faults and fracture sets defined based on their orientation and on the chronological relationships (1) between sets, and (2) with respect to bedding attitude. We conducted U-Pb dating of syn-kinematic calcite in fractures developed during layer-parallel shortening (LPS), fold growth, and late-stage fold tightening (LSFT).

The timing of fold growth is either constrained directly by the age of curvature-related fractures and bedding-parallel slip surfaces or bracketed between the most recent fracture related to LPS and the oldest fracture associated with LSFT. Results reveal that the Mirabeau anticline developed shortly (~5-10 My), between 45 Ma ( $\pm 2$  Ma) to 40 Ma ( $\pm 5$  Ma), during the Pyreneo-Provençal orogeny. The fold cross-section restoration indicated a shortening of ~26% at a mean rate of ~500 m/My as constrained by U-Pb dates. The minimum duration of the entire folding event, of ca. 12 My, is obtained by considering the oldest LPS-related vein (~52 Ma  $\pm 8$ ) and the youngest LSFT-related vein (36 Ma  $\pm 1.2$ ).

Over the course of the folding event, the mineralizing fluids have similar chemistry. Indeed, clumped isotope ratios  $\delta^{47}\text{CO}_2$  obtained from syn-kinematic calcite sampled in both LPS and syn-folding mesostructures reveal that the calcite precipitated from a fluid with a  $\delta^{18}\text{O}$  value

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\*Intervenant

between -2‰ and 0‰ SMOW. However, the apparent temperature of precipitation differs significantly between LPS (65-74°C) and fold growth (53-57°C). If we consider that the fluid system remained constant meanwhile (i.e. without opening to an external source of fluids), the decreasing temperature can be simply explained by exhumation related to syn-folding erosion.

**Mots-Clés:** Folding, Fracture sequence, Paleofluids, stable isotopic geochemistry, U, Pb dating