1. Lithologies

All lithologies are carbonaceous rocks. Compressive tension gashes inside sigmoidal deformation were sampled in the Fournel Valley location. In the Reotier location, boudinage veins are markers of significant flattening related to thinning of sedimentary units in a compressional context. In L'Argentière location, compressive features are expressed at fold extrados quartz-calcite veins. Metre-scale folds also mark an important flattening related westward to nappe westward transport.

Extensional and compressionnal features were sampled in the Tête d'Oréac location. Eastward of the Tête d'Oréac and southward of the Tournoux scarp, the Col de la Pousterle (Pousterle pass) outcrop is featured by a normal fault with significant offset (> 300m, Fig. 3a). This fault is part of the High-Durance Fault System (HDFS). Here, en-echelon normal veins were sampled. A consistently sub-horizontal S0+S1 was measured. Conjugated faults are locally more expressed, but eastward dipping faults are also dominant here. En-echelon veins are vertical and related to normal faults, and are exclusively composed of calcite. Tournoux and Ponteil scarps show larger metre-scale cataclasite extensional structures with consistently dominant eastward dipping orientations.

Table S1: Sampling sites location

Location	Latitude	Longitude	Lithology	Stratigraphy
Falaise scarp (U-Pb dating)	44°48'29.75"N	6°30'31.38"E	Dolomitic limestone	Middle Triassic (Anisian)
Fournel Valley	44°47'22.33"N	6°27'21.14"E	Flysch (Champsaur sandstone)	Upper Eocene (Priabonian)
Tête d'Oréac	44°48'0.64"N	6°30'10.12"E	Planktonic calcschist	Upper Cretaceous - Paleocene
Col de la Pousterle	44°47'56,03"N	6°30'52,75"E	Calcschist	Upper Cretaceous
L'Argentière	44°48'10.33"N	6°33'34.83"E	Silliceous calcschist	Upper Jurassic (Malm)
Ponteil scarp	44°42'48.25"N	6°33'56.83"E	Calcschist	Middle Triassic
Réotier	44°40'0.57"N	6°35'51.45"E	Limestone	Middle Triassic (Anisian)

Table S1. *GPS coordinates of outcrops. Lithology and stratigraphy are based on field observations and 1/50 000 geological map.*

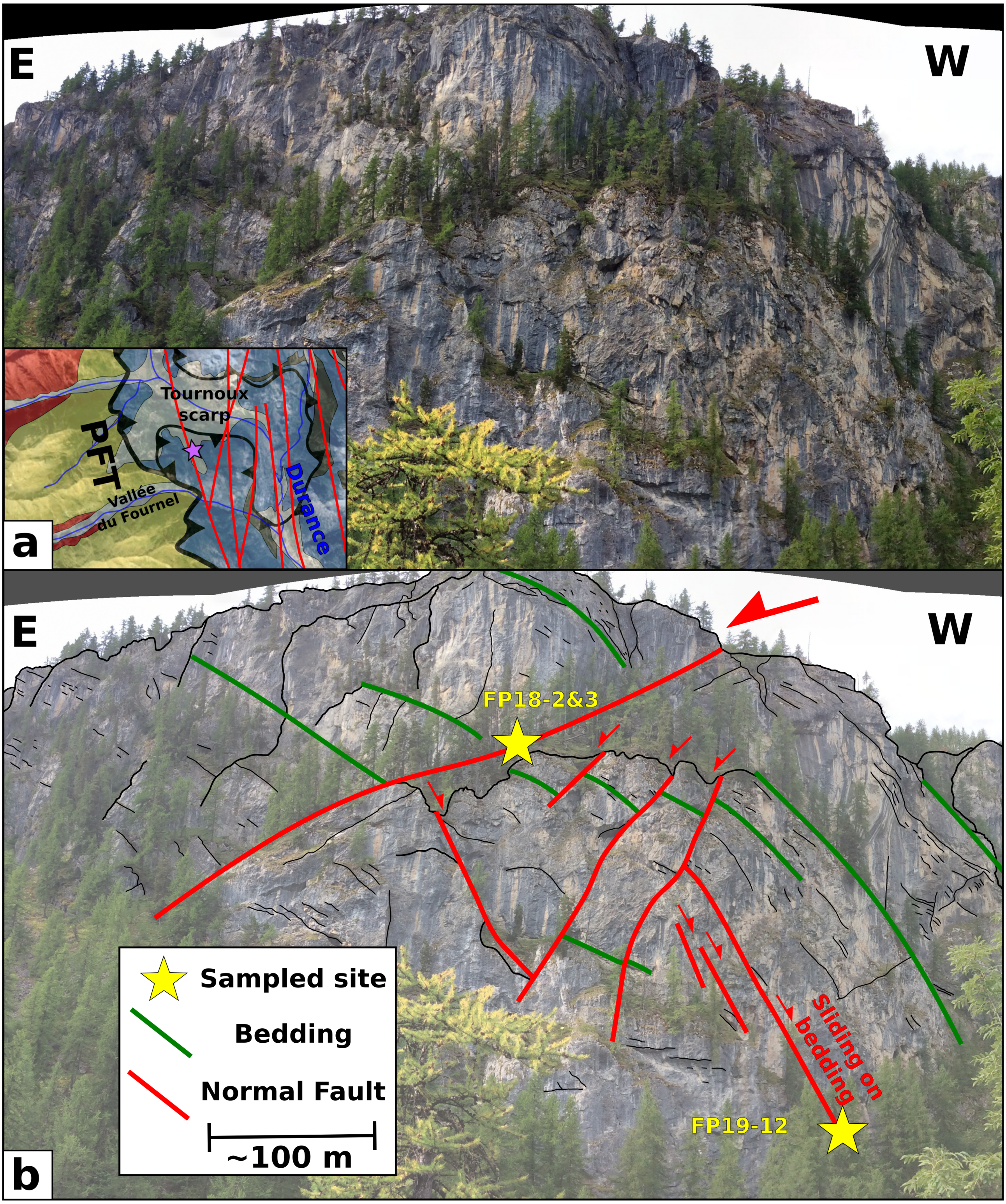

Fig. S1. Panoramic view of the Tournoux scarp. High-Durance normal faults and sampling sites of FP18-2&3 and FP19-12.

Located on the northern side of the Tête d'Oréac, the Tournoux scarp is the other side of the so-called Tête d'Oréac scarp presented in Fig. 3a. Here, the dolomitic limestones dip towards the west with a variable dip. The two dated cataclasites were sampled on the same scarp, on distinct conjugated extensional structures (Fig. S1). Sample FP18-2&3 are representative of the main eastward normal fault motion and sample FP19-12 is related to conjugated eastward normal fault motion. The ~20-50° west dipping bedding locally acted as a weakness plane concentrating the extensional deformation. When the bedding and faults are nearly of same dip, this results in sliding on the bedding surface (Fig. S2a). Locally, both east and west-dipping fractures are observed (Fig. S2b). Sample FP19-12 came from the main fault (Fig. S2a), it show multiple calcite filling generations (Fig. S2c), as confirmed by petrogaphic analyses (Fig. S3&S4). In the field, two slickenside orientations are measured, of ~50 and ~70° dip, towards the north. The older ones correspond to the steepest generation, clearly showing a main normal component, while the younger ones show a partly dextral strike-slip component (Fig. S2d).

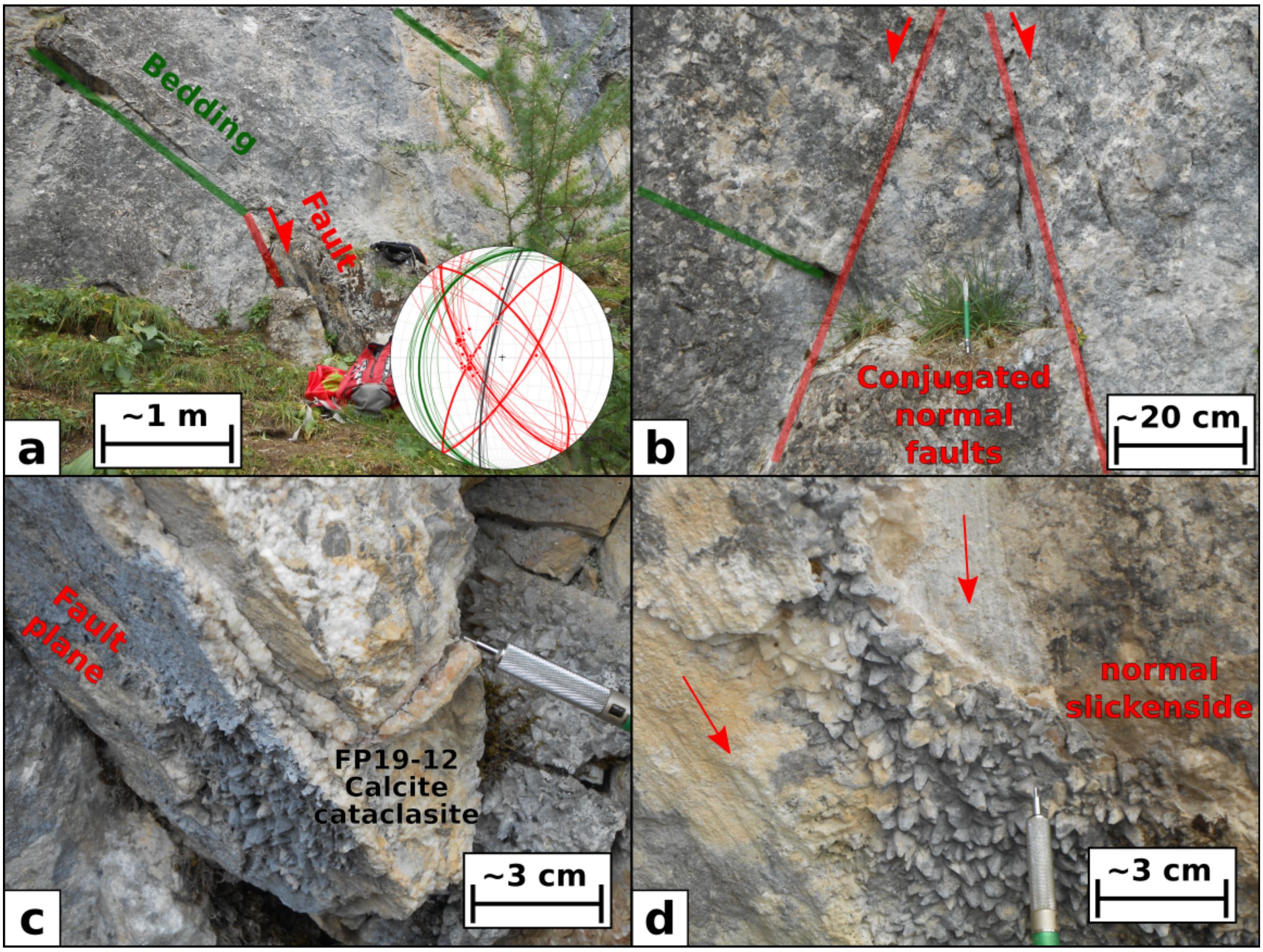

Fig. S2. *Field photographies of FP19-12 sampling site of Tournoux scarp, with the corresponding Wulff stereogram, in lower hemisphere (colours in the stereogram refer to colours of highlighted structures on the picture).*

2. Geochemistry

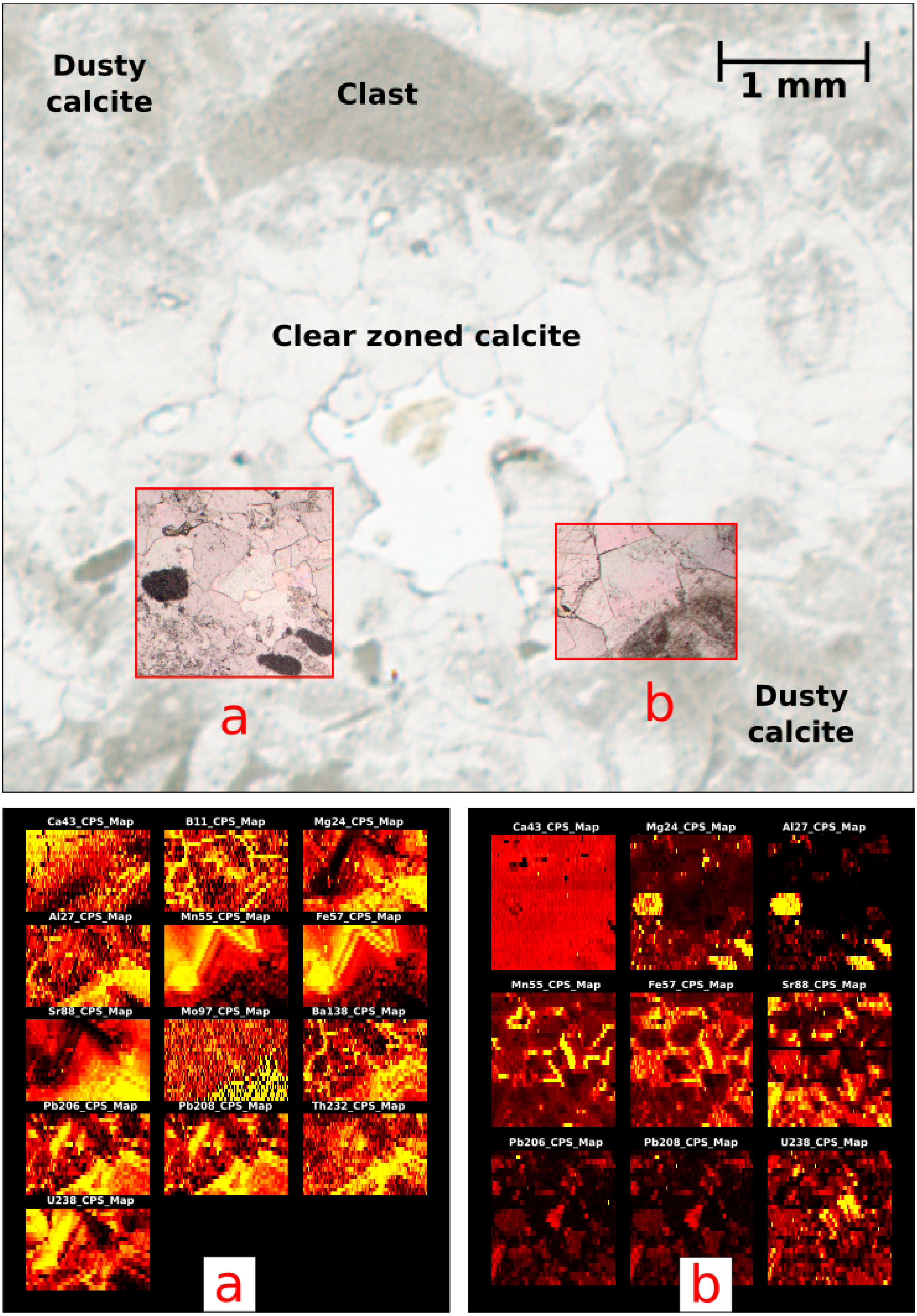

Fig. S3. *Elemental maps of the cataclasite filling calcite showing (a) compositional patterns in the so-called « clear » calcite and that recrystallized between clast and (b) the boundary with the « dusty » calcite corresponding to cataclasite clasts (thin-section FP18-2B). Zonings appear in the clear calcite.*

Two elemental maps of FP18-2B cataclasite calcite fillings were acquired (Fig. S3). In the map B, 13 elements were monitored. The limit between clear calcite zoned crystals and dusty calcite is well marked in ^{55}Mn, ^{57}Fe and anti-correlated to ^{88}Sr.

Two additional maps were produced in the thin section FP19-12B, with similar zoning features as in sample FP18-2&3 cataclasites (Fig. S4).

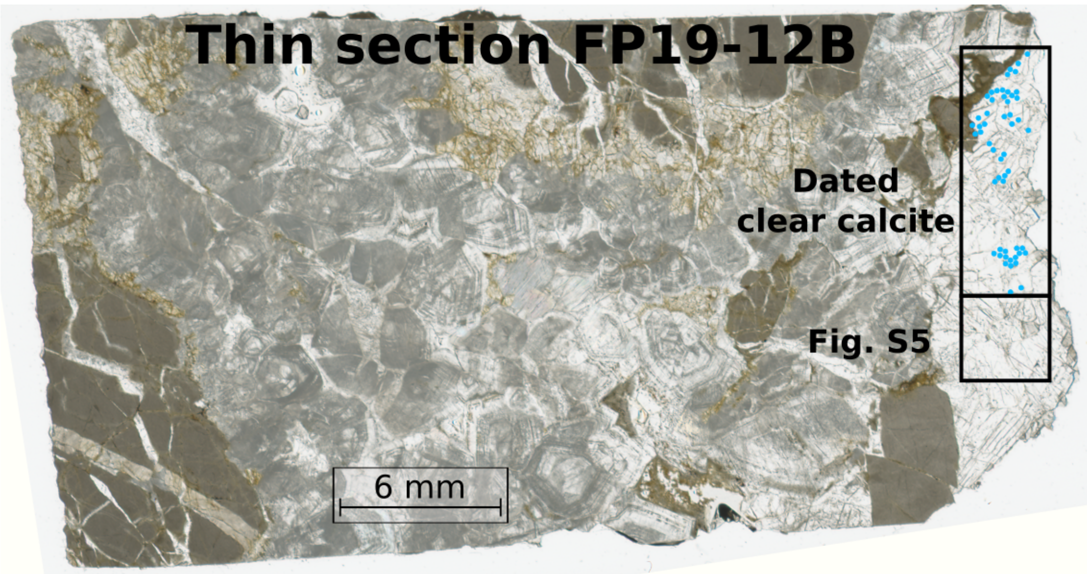

Fig. S4. *FP19-12B thin section with mapped and dated zones.*

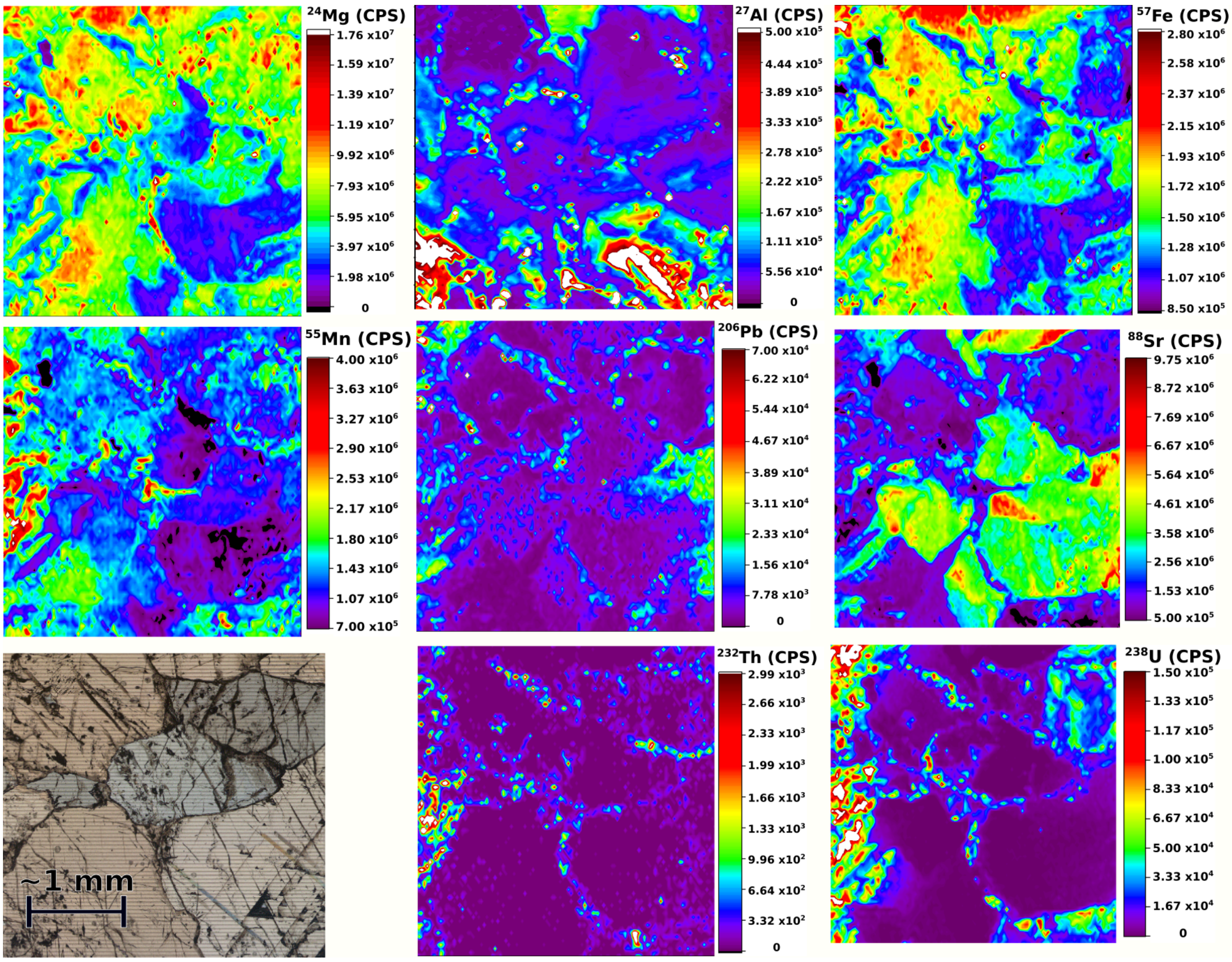

Fig. S5. *Trace element maps in dated cataclasite filling clear calcite, expressed in CPS (Count Per Second), thin-section FP19-12B. The spot size is 30 µm and the map is 80 lines.*

Blocky texture is observed in dated clear calcite fillings (Fig. S5). Calcite appears as fractured crystals of nearly 1 mm size. ^{238}U, ^{232}Th and ^{206}Pb contents are higher at crystals interfaces and show very moderate and homogeneous contents inside the crystals. Other elements show a large variability inside crystals with similar patterns for ^{55}Mn and ^{24}Mg. High ^{24}Mg content can be a marker of dolomite. ^{88}Sr content vary from 5.10^5 to $8.72.10^6$ CPS, two groups of crystals can be defined based on average ^{88}Sr content, ~4.10^6 and ~7.10^5 CPS. In each group, ^{88}Sr content is homogeneous, which suggest that several crystallization phases occured. At crystals interfaces, ^{238}U content range from ~2.10^4 to $1.5.10^5$ and relative low content of ^{206}Pb range from ~0 to 2.10^4, the ratio of ^{238}U/ ^{206}Pb goes to more than 100. Thus, due to the laserspot size, it is likely that we dated this late calcite that crystallized along crystal interfaces.