A new heating/cooling stage designed for fluid inclusions measurements in large stalagmite sections

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In order to measure homogenisation temperatures of fluid inclusions in stalagmites the samples have to be broken to small pieces to fit on the Linkam THMSG 600 microscope heating/freezing stage that is currently used for microthermometric measurements. However, this makes a reconstruction of the chronological succession of the fluid inclusions difficult and requires extensive documentation. Therefore we have constructed a new microscope heating/cooling stage (Fig. 1) that is suitable for measurements of large sections fixed on a 300 µm thick carrier glasses with 28x48 mm standard dimensions. The stage is designed for a temperature range between 0 and 35 °C.

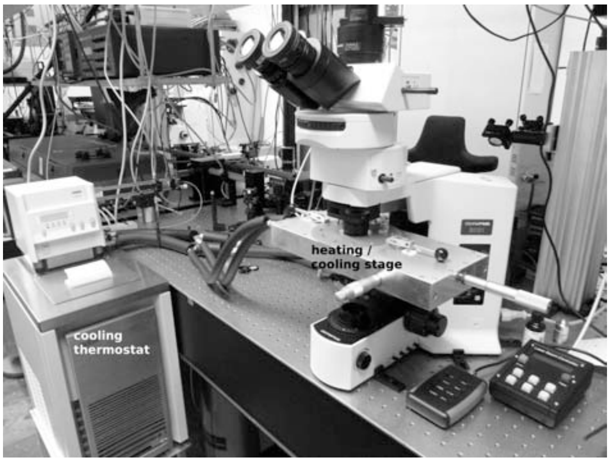

Fig. 1. Overview of the system with the cooling thermostat and the microscope heating/cooling stage. To load the stalagmite sections the upper block of the stage can be removed without disengaging connecting pieces.

The new stage makes the temporal reconstruction of fluid inclusion data more precise and efficient as the sections can be systematically scanned for suitable inclusions by a precise x-y translation of the sample. Additionally the preparation of the stalagmite samples is simplified because the sections remain on the 300 µm thick glass substrate that is used for sawing.

Fig. 2 shows a cross section through the stage with the upper and the lower copper block. Twin core heating elements (1) are used to heat against permanent cooling of -10 °C (2) realised by a cooling cryothermostat (Lauda RP 885). The stage can be used with a high NA objective (3) and condenser (4) whereby v-seals (6) tighten the measurement chamber. The sample (5) can be moved in x-y directions by micrometer screws. The temperature is measured by PT-100 sensors in each block and regulated by a PID (proportional-integral-derivative) controller.

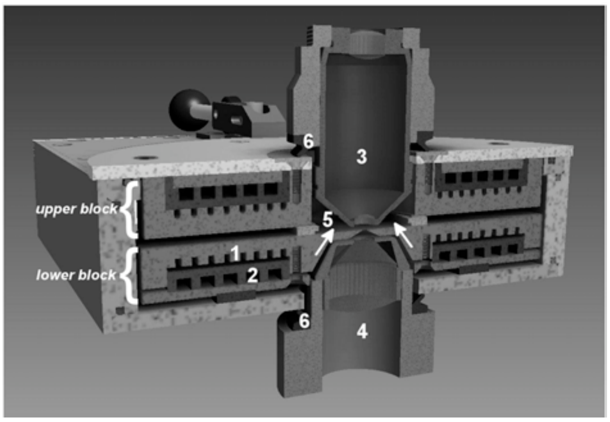

Fig. 2. Cross section of the heating/cooling stage. The objective and the condenser lens can be inserted into the copper blocks. The upper block is removable to load the sample. (1) heating elements, (2) cooling channels, (3) oil immersion objective fixed in a nylon jacket with v-seal (6), (4) condenser (NA 0.9) fixed in a nylon jacket with v-seal (6), (5) sample holder.

Since we use immersion oil to make the section transparent for microscopic observation we can use an oil immersion objective (NA 1.3) that provides improved optical resolution and image quality compared to the commonly used long working distance objectives (see Fig. 3). Additionally the oil immersion objective provides significantly higher transmission for the 800 nm wavelength of the femtosecond laser that is used to nucleate the vapour bubble. Thus the available pulse energy is increased and vapour bubble nucleation can be induced in larger depths within the section (cf. Krüger et al., 2007).

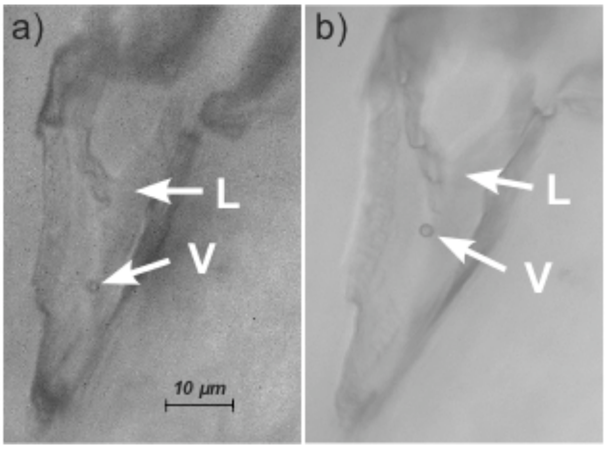

Fig. 3. Microphotographs of a two-phase inclusion in a stalagmite after laser-induced vapour bubble nucleation, (a) imaged by an Olympus LMPlanFL 100x/0.80 LWD objective, and (b) imaged by an Olympus UPLFLN 100x/1.30 oil immersion objective.

For temperature calibration of the stage a PT-100 temperature sensor was used to simulate the sample under measurement conditions. Because of the contact between objective and sample via the oil film, the calibration of the stage has additionally to account for variation of the room temperature.

REFERENCE

Krüger, Y., Stoller, P., Riĉka, J., Frenz, M., (2007). *Eur J Min* 2007, 19, 693–706.