Light induced movement of the gas bubble in natural fluid inclusions

Kribitz, G.A.

Teichweg 7, A - 8724 Spielberg; gerald.kribitz@hotmail.com

During microscopical investigations on fluid inclusions I mentioned, that the gas bubble inside specific fluid inclusions can be moved by changing the intensity of the light. This light induced effect can be observed in highly saline aqueous fluid inclusions, which contain also methane in the vapour phase and could be recognised exemplarily by samples of calcite, garnet and diopside.

Inside of fluid inclusions which are, fixed at the microscope stage and externally unmoved, the gas bubble, which otherwise is also unmoved, can be moved reversibly by just changing the intensity of microscope light. At constant light conditions the bubble keeps the new position inside the fluid inclusion constantly (Fig. 1).

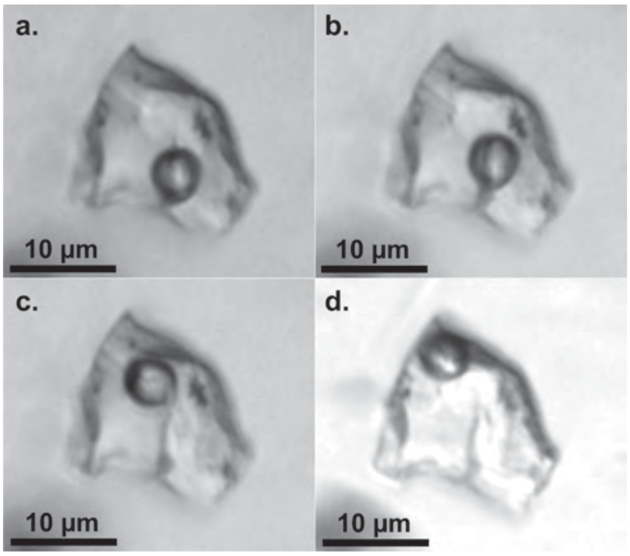

Fig. 1: A series of microphotographs, using different intensities of illumination, showing a highly saline fluid inclusion with a methane- bearing gas bubble inside diopside, at a temperature of 380° C, unpolarised transmitted light. Movement and positions of the gas bubble at different intensities of the illumination.
a.: weak illumination
b.: intermediate illumination
c.: strong illumination
d.: very strong illumination

The gas bubble remains fixed during weak illumination, for example, at the lower part of the image (Fig. 1a), it moves during intensifying the illumination, proportional to the intensity of the illumination, towards the upper border of the image (Figs. 1b, 1c), until, according to a certain light intensity, a maximum external position is reached (Fig. 1d). If then the intensity of the light is even enlarged, the bubble moves toward its initial position again. Generally during constant illumination conditions the gas bubble remains unchanged in its particular position.

The intensity of this light effect is variable at different temperatures, at higher temperatures the gas bubble becomes more mobile, what can be inferred from different reasons (e.g., dissolution of the salt crystal, downsizing of the gas bubble, causing better trajectory; the ratio of the cross section of the gas bubble, which is approximated as a globe, to the corresponding volume of this globe increases; the difference between the densities of the liquid phase and the gas bubble reduces).

There is no difference, if non-polarised light or plane-polarised light is used or if white or bluish light is used. Only the intensity of the light is controlling this effect. The direction of the induced movement is constant if the surrounding conditions are unchanged and also, if using polarised light, that direction is not be changed by rotating the plane of polarisation.

In literature (e.g., Oshemkov et al. 2009) interactions are described, laser light (monochromatic, coherent light of high energy) can evoke on fluid inclusions. I also recognised repeatedly, that gas bubbles inside fluid inclusions seem to „avoid“ the spot, were a laser beam is centered. Those interactions caused by laser radiation are explained by local heating phenomena, similarly to the actions inside a light mill. That try of explanation however, is not suitable for the situation presented in this paper, because the effect described previously can not be, what would be due then, observed at all types of fluid inclusions. This light effect is only mentioned in highly saline, methane- bearing fluid inclusions, which are very special in their chemical composition.

The light effect presented in this study (methane- bearing gas bubble inside a highly saline fluid inclusion can be moved pointedly by changing the intensity of the impinging light, produced by a simple bulb) has not been reported before in literature.

Based on the fluid inclusion imaged in Fig. 1, the force, generated by light against that gas bubble at a temperature of 380 °C, can be calculated approximately, also using microthermometrical data (Kribitz 2010) and computer programs (Bakker 2003). The force to move this gas bubble in the fluid inclusion is about $5,8*10^{-13}$ [N] with a corresponding pressure against the bubble of about $3,2*10^{-2}$ [N/m^2].

Due to the ability to move material under the influence of light, possible applications of that effect could include, for example, the development of new types of engines and in the reversion the production of energy or various measuring tools.

Bakker, R.J. (2003): Package fluids 1. Computer programs for analysis of fluid inclusion data and for modelling fluid properties. - Chemical Geology, **191**: 3-23.

Kribitz, G.A. (2010). - Masterarbeit Montanuniversität Leoben, Leoben.

Oshemkov, S.V., Dvorkin, L.P. & Dmitriev, V.Y. (2009): Trapping and manipulating gas bubbles in water with ultrashort laser pulses at a high repetition rate. - Technical physics letters, **35**/3: 282-285.