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Trace-Element Analysis by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS): a Case Study for Agates from Nowy Kościoł, Poland

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Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) was applied to detect trace elements in agate from Permian volcanics (Nowy Kościoł, Poland) in low concentrations and with high spatial resolution. The used LA-ICP-MS system consists of a DUV 193 laser ablation system linked to a Thermo Finnigan Element 2 mass spectrometer. The use of a 193 nm ArF excimer laser (50-200 mJ energy output) and the standards NIST 611 and NIST 612 enables to produce and analyse small crater diameters down to 5 µm.

Trace-element profiles have been analyzed for the elements Ti, Ge, Al, Fe, Mn, U, Th, Ba, Sr, Rb, Cs, and Y in the ppm- and sub-ppm level. The concentrations of the REE are sometimes below the detection limit of the method. Almost all elements (except Cu) display higher contents in chalcedony than in the macrocrystalline quartz. Fe, for instance, shows a 100 times higher concentration in agate bands compared to quartz, which may be due to finely distributed iron oxide particles in the chalcedony which probably act as colour pigments.

The trace elements in agate are released simultaneously with Si during alteration of the surrounding volcanic rocks. Oxygen isotope data indicate that silica accumulation and agate formation took place at temperatures below 120°C. The characteristic trace-element distribution patterns in agate result from a "self-purification" process during crystallization of chalcedony and quartz from a silica gel.

Keywords: agate, quartz, trace elements, LA-ICP-MS, oxygen isotopes, CL, Nowy Kościół.

1. Introduction

Agates are banded forms of microcrystalline α-quartz (chalcedony) and often form spectacular, multicoloured geodes or veins. These forms of SiO_2 can be found all over the world (Zenz 2005). Despite the intense research concerning the conditions of agate formation during the last 150 years,

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