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1 Measurement of elastic properties of alunite by Brillouin spectroscopy

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We determined the single-crystal elastic constants of natural alunite (ideally $KAl_3(SO_4)_2(OH)_6$) by Brillouin spectroscopy. The crystals were analyzed by X-ray powder diffraction and electron microprobe, verifying that the sample is a single-phase material corresponding to alunite.

Alunite and related Fe-Al sulfates attract attention because they are associated with acid mine drainage, a widely recognized environmental problem (Jambor et al. 2000). There is also increasing interest in sulfates as important components of planetary surfaces, for example on Europa (Zolotov and Shock 2001) or Mars (Blaney and McCord, 1995). Characterization of the elastic properties of hydrous sulfates is an important step in constraining the overall thermodynamics of these phases.

Brillouin experiments were performed with a 2 W Nd;YVO_4 laser, generating an excitation radiation with wavelength of 532 nm. Inelastically scattered photons were analyzed by a six-pass Sandercock tandem Fabry-Perot interferometer and recorded by a solid-state detector. The elastic constants (in GPa), obtained by fitting the spectroscopic data, are C_{11} = 181.9 $\pm$ 0.3, C_{33} = 66.8 $\pm$ 0.8, C_{44} = 42.8 $\pm$ 0.2, C_{12} = 48.2 $\pm$ 0.5, C_{13} = 27.1 $\pm$ 1.0, C_{14} = 5.4 $\pm$ 0.5. The VRH average of bulk and shear modulus is 62.6 and 49.4 GPa, respectively. The average Poisson ratio and the elastic Debye temperature is 0.19 and 654 K, respectively. The high value of the ratio C_{11}/C_{33} = 2.7

and the large discrepancy between the elastic and heat capacity Debye temperature are characteristic of the anisotropic structure of alunite.