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On the optical/thermal properties of basalt glass geomaterial: A correlation between phonon thermal conductivity and refractive index of light

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Two variants of relationship between the Phonon Thermal Conductivity k(T) and seismic parameter F for geomaterials are presented. The research was based on the Debye's model of lattice vibrations and on the Anderson-Jordan seismic equation of state. Thermodynamical laboratory data of main silicate and oxide minerals in the form of polycrystalline aggregates were also used. A correlation between the optical specific refraction sR = (n-1)/d (where n and d denote the refractive index of light and density of medium, respectively) and pressure p (from 0 to 5 GPa) for oceanic basalt glass is considered. This glass with the mean atomic weight $<A>$ = 22.8 g/mol contains about 50% of silicon dioxide. The studies are based on the Lorentz electron theory of solid phase. The eigenfrequency of elementary electron oscillators, in energy units hfo (h denotes the Planck's constant), is identified with the mean first ionization potential of non-free atoms composing the given medium. This mean potential, on the other hand, can be identified with the energy gap EG or with other interband transitions at Eg $>$ EG. Necessary experimental data on the refractive indices and densities were taken from R.G. Kuryaeva and V.A. Kirkinskii (1997). With very good approximation, sR is constant and equals 0.2035 cc/g in whole 0-5 GPa range. In this case (dsR/dp = 0), we have a very simple equation: dn/dp = sR/F. Since the mean value of dn/dp is about 0.0120/GPa and sR = 0.2035 cc/g, we obtain that F = 16.98 (km/s)ˆ2 for basalt glass. At room temperature To relation of the form log k(To) = (5/6)log F(To) - 0.7422 is valid. Thus, we obtain the interesting value of k(To) = 1.92 W/m K. It is in good agreement with the PTC of polycrystalline biotite and similar silicate minerals.