Geology, Geophysics & Environment 2016, vol. 42 (1): 63–64

Microhardness as a method for investigation of fossil resins

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Natural fossil resins are products of deciduous and coniferous trees formed at least 40 million years ago. The fact that fossil resins survived until the present day is due to appropriate processes and conditions. One of them is the ability to polymerize. There are types of chemical structures derived from the original plant secretions which formed polymerized or macromolecular connection resistant to various environmental factors (Penney 2010). The polymerization process gives property of better susceptibility to mechanical machining, and thus jeweler's usefulness (Matuszewska 2015). Fossil resins are being found along the southern coast of the Baltic Sea (from Jutland Peninsula to the Sambia) and ranges stretching trough Germany, Poland, Lithuania, Latvia, Belarus and Ukraine (Czechowski et al. 1996, Heflik & Natkaniec-Nowak 2011). They are also occurring in other locations, for example in Mexico, Dominican Republic, Colombia and SE Asia (e.g. Myanmar, Indonesia).

The most commonly used diagnostic methods for fossil resins are spectroscopic methods (FT-IR, RS) (Kosmowska-Ceranowicz 1999a). They allow identification of different varieties of resins and get to know their internal structure (Czechowski et al. 1996, Kosmowska-Ceranowicz 1999b, Matuszewska 2010, 2015). Quantification possibilities have also other methods, such as X-ray fluorescence, diffractometry, and most of all – chemical methods. In recent years, t method for determining the absolute hardness (microhardness) (Matuszewska & Gołąb 2008) was added to these analytical techniques. This parameter clearly shows the relationship between physico-chemical features with different aspects of their genesis. It can be helpful in determining the age of resins (Matuszewska et al. 2002). Hardness as the primary diagnostic feature of many minerals is evaluated relatively to model of 10 minerals in Mohs scale. Reported in the literature (Savkievich 1967, Popkova 1984, Matuszewska 2009), hardnesses of fossil resins are from 1 to 3, which correspond to hardness of talc (1), gypsum (2) and calcite (3). It therefore varies; for succinite (which is treated as a model for fossil resins) range is from 1.5 to 3, while Colombian copal from 1 to 1.5. It depends mainly on the degree of macromolecular structure condensation of these materials.

The subjects of the study were samples of fossil resins selected from Mexico (Chiapas), Dominican Republic (Barahona) and Colombia (Velez). In addition, for comparison purposes Baltic succinite were measured. The measurements were done in Gemological Laboratory at WGGiOŚ AGH using a microhardness tester PMT-3 from Russian manufacturer. For the determination of this parameter Vickers method was used, according to which the microhardness determines the ratio of the pressure force of diamond pyramid with load to the lateral surface of the depth print. For measurement, 250 mg load. The test was conducted on the smooth surface of each of 6 samples repeating the measurement 20 times.

The obtained results allow concluding clearly that the individual fossil resin samples are significantly different from each other. These differences

http://dx.doi.org/10.7494/geol.2016.42.1.63 ISSN 299-8004 | e-ISSN 2353-0790 | Wydawnictwa AGH

result from different places of origin and age, thus the conditions of the geological, natural environment, climate, etc. Average value of the microhardness for fossil resins from Mexico and Colombia is the lowest – respectively 18.54 kG/mm^2 and 19.87 kG/mm^2. In turn, the value of this parameter for the samples from Dominican Republic is significantly higher (yellow resin – 26.59 kG/mm^2; orange resin – 27.76 kG/mm^2; dark red resin – 26.57 kG/mm^2). Succinite achieves the highest values of microhardness in comparison with other resins. This is due to the difference in their ages – Eocene Baltic amber, is the oldest studied resin, therefore condensation processes in the structure are more advanced. Slightly lower values achieve Miocene – Oligocene resins from Dominican Republic. Lower Miocene – upper Oligocene and Pleistocene – Pliocene samples from Mexico and Colombia, have the lowest microhardness.

The differences in microhardness of various resins may be explained by the fact that their fossilization underwent in different environmental conditions. The environmental conditions were different in various geographical locations. The degree of condensation and polymerization of the resins and their hardness increased with time. Therefore, in case of the oldest investigated resin, succinite-Baltic amber, the measured microhardeness was the highest.

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