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Using destructive and non-destructive techniques in characterising raw "hypersiliceous" sedimentary rocks of Belgium used in prehistory and history

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Over time archaeologists and historians have discussed the geological and geographical origin of very silica-rich stone materials (> 90% SiO_2) introduced here as hypersiliceous rocks. These rocks are widely distributed in Belgium and belong to different stratigraphical levels from Cambrian to Tertiary in age, including sedimentary and low metamorphic quartzites, silicified limestones, nodular and layered chert and flint, very fine grained, siliceous, organic-rich rocks (phtanites) and biosiliceous rocks such as radiolarites. The terminology in defining and categorising different silica-rich rocks is complex and differs between countries and disciplines referring to archaeology and geology. This makes a uniform nomenclature necessary, which is one of the challenges of this research.

The application in prehistory and history of hypersiliceous rocks ranges from work tools to foundation and building material, millstones, refractory material, flintlocks and other objects of our cultural heritage. Generally, the assumptions concerning the extraction source of the stone material rely on macroscopic lithological characteristics. In case of hypersiliceous rocks, this visual macro- and mesoscopic approach is often insufficient to differentiate between similarly looking hypersiliceous rocks of different age and/or geographical outcrop. More detailed studies of these hypersiliceous rocks with common physical features and similar physico-chemical properties are now in progress for a proper identification and classification.

So far, several studies have been carried out to identify and source silica-rich rocks, but not in Belgium. In these studies, different non-destructive techniques were applied to the surface of the raw sample as well as of the stone object. These techniques range from scanning-electron-microscopy (SEM), LA-ICP-MS to cathodoluminescence, giving no unequivocal results. In those cases, it seems necessary to revert back to destructive techniques such as making a classical thin section of the rock sample as in our ongoing research. Usually enough stone material of less aesthetic value is available at the site. In the ongoing research, raw rock samples are grouped on the basis of macroscopic observation of colour, grain size, fracture and macro-texture. Discrimination between rock samples within a same group is possible using a polarizing microscope to study the differing micro-texture and cement mineralogy of the thin sections of the samples. Cathodoluminescence allows us to semi-quantify quartz cements and to determine the original morphology and origins of the grains. Another application of cathodoluminescence is attaining the mineralogy of heavy minerals and apatites, which are difficult to assess with classical optical microscopy. EDS-SEM is used as a complementary technique in assessing the mineralogy of a grain (point analysis) and of a limited surface (mapping analysis). The very fine grained rocks (chert, flint, phtanites, radiolarites...) are analysed with X-ray diffraction to specify the mineralogy of the rock and the degree of quartz cristallinity. Also a non-destructive method is being tested with Raman spectroscopy on phtanites, which are organic-rich, very fine grained rocks. It allows us to obtain information on the burial history of phtanites from different stratigraphical and possibly geographical units.

The final result will be a reference collection of hypersiliceous rocks on Belgian territory, composed from samples of existing collections and samples collected during field work. The reference collection will mention the stratigraphical position, the outcrops, the petrographic descriptions and geochemical characteristics of each unique rock type. Information on the sites of extraction and the degree of transformation from raw material to finished product allows archaeologists and historians to describe the distribution of the material and to reveal potential

trade contacts. This reference collection will make it possible to compare and match archaeological and historical artefacts with Belgian hypersiliceous source rocks.