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Valorisation of mine and quarry waste in production of sustainable cements

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Various industrial residues that are either landfilled or currently have a low recycling rate could represent important secondary mineral resource potential for the construction sector. An ever-increasing construction sector causes increased demand for cement-based materials and consequently implies in increase of CO_2 emission. Belite-sulfoaluminate cements are potentially an alternative cementitious binder to ordinary Portland cements, due to the lower embodied energy and reduced CO_2 emissions compared to OPC clinkers. Its production also allows the substitution of natural raw materials with secondary ones. In the frame of RIS-ALiCE project, funded by the EIT RawMaterials, various industrial and mine residues in Eastern-Southeastern Europe are being mapped. In addition, as a matchmaking tool between the waste holders/producers and potential end-users the registry of secondary mineral raw materials has been developed. In this study, mine and quarry residues have been valorised in order to evaluate their suitability for production of innovative and sustainable low CO_2-mineral binders. Residues from three mine sites (mine spoils from two Pb-Zn mines from Slovenia and Serbia and brown coal open pit mine from Slovenia) and two quarry sites (limestone quarries from Slovenia) were considered. Samples were characterized with respect to their chemical, mineralogical, physical and radiological properties. Furhermore, to assess the usability of particular residue in cement production, cement clinkers with belite, calcium sulfoaluminate and ferrite as main phases were synthesised, incorporating certain amounts of mine and quarry waste replacing primary raw materials. Main and trace elements as well as REE of residues were determined by X-ray fluorescence spectroscopy and ICP optical emission spectrophotometry. Mineralogical composition of residues as well as sythesised clinkers was determined by X-ray powder difraction and Rietveled method. Content of radionuclides (^{40}K, ^{226}Ra, and ^{232}Th) was determined by gamma spectroscopy. Depending on the chemical

composition of the residues, lower or higher amounts were allowed to be incorporated in the raw mixture for clinker production with targeted phase composition. Potential barriers in the cement production and environmental impact are also discussed. Developed registry with the data valuable for both, waste providers as waste users in Eastern-Southeastern Europe region, can be later-on upscaled also to other regions of Europe. It will provide the data on the available and appropriate secondary resources for cement production which will contrbute to the implementation of sustainable management of raw materials and circular economy.

Keywords: mine waste, quarry waste, cement, valorisation.