ACTA UNIVERSITATIS SZEGEDIENSIS

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ACTA
MINERALOGICA-PETROGRAPHICA
ABSTRACT SERIES

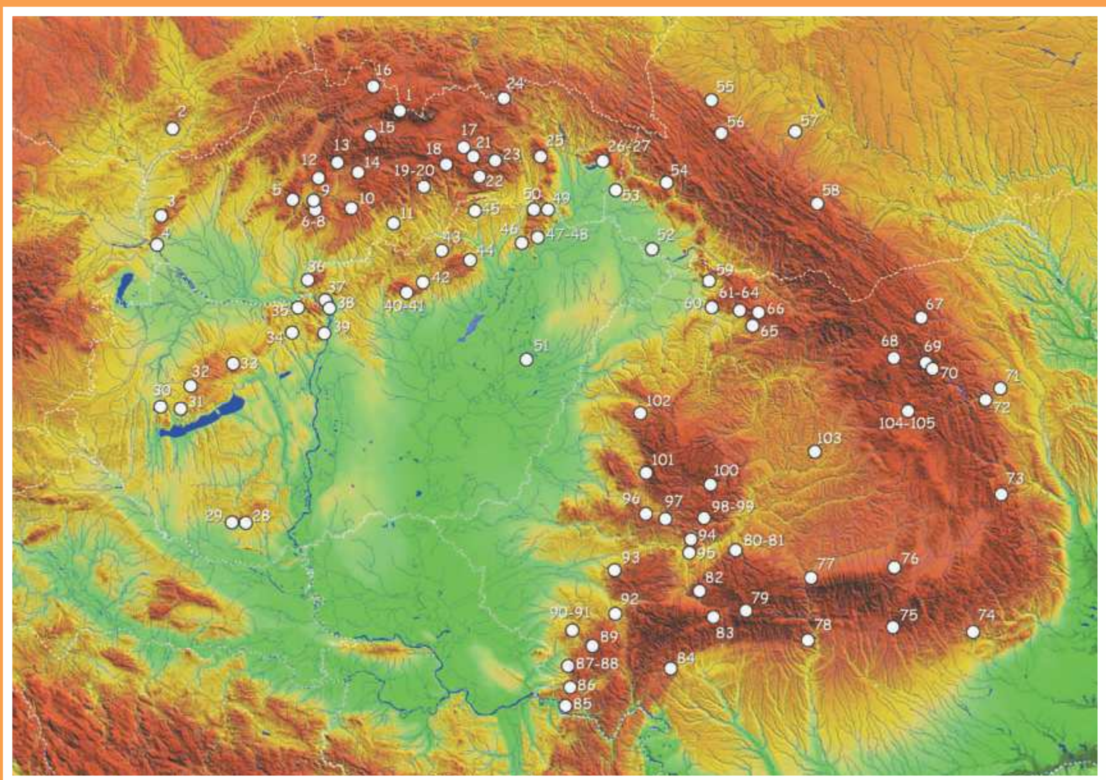
Volume 6 2010

IMA2010

20th General Meeting of the International Mineralogical Association
21–27 August, 2010

Budapest, Hungary

NKTH
National Office for Research and Technology



Published by the Department of Mineralogy, Geochemistry and Petrology, University of Szeged

Characterization of the concrete alkali reactivity of granitoid and dolomitic aggregates

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The general designation of "internal expansive reactions" includes the alkali-silica reaction (ASR) and the internal sulfate attack by delayed ettringite formation (DEF). These reactions are characterized by the formation of expansive compounds in hardened concrete and consequent cracking of the structure. In Portugal, the number of structures, mainly dams and bridges, affected by ASR is very significant and in some cases require considerable investment in rehabilitation interventions.

Moreover, previous research [1] has shown that the use of some aggregates, initially regarded as inert, can cause problems, proving the need for further insight on the role of aggregates and prevent the occurrence of ASR in constructions.

The economic value of various types of structures (e.g. dams, bridges, airfields) and the high costs related to structural degradation including losses of functionality and the permanent or temporary unavailability (for repair and rehabilitation) could be an important overthrow. Thus thorough understanding of the earth materials requirements for concrete manufacture are of vital economic importance in view of the prevention of deterioration and aging of structures whose longevity and functionality must be guaranteed. It is imperative to provide the concrete producers with the necessary knowledge in order to avoid this type of concrete degradation. Particularly important is the recently approved Lisbon-Madrid High Speed Train railway construction. This expensive operation will require large quantities of aggregates for the construction of bridges and other concrete infrastructures.

Three main sources of raw materials will be considered for the study: St. Eulalia, Montemor and Cano. These quarries are already major exploitation sites separated by 50 km and not far from the future High Speed Train railway. Two of them are granitoid rocks but the raw material from St. Eulalia is richer in quartz and poorer in ferromagnesian minerals than the Montemor aggregates (fig. 1 left). The enrichment in calcium of feldspar goes together with the iron and the magnesium. The Cano aggregates (fig. 1 right) are very different materials. The main lithology is a dolomite rock with local microscopic enrichments in phyllosilicates and very deformed quartz.

Fig. 1: Aggregates from Montemor (left) and Cano (right) quarries.

Mineralogical and textural characterization of the aggregates was done by optical microscopy. The crystallinity of quartz was also evaluated by XRD and FTIR. The aggregates were also studied by accelerated expansion mortar-bar and concrete-prism tests to evaluate their potentially alkali-reactivity. The relationship between aggregates characteristics and their behaviour in what concerns to alkali reactivity will be discussed.

[1] Santos Silva, A. (2005) *PhD thesis*, University of Minho, Guimaraes, Portugal.

Ettringite mapping by X-Ray diffraction computed micro-tomography and quantitative image analysis

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The formation of ettringite plays a critical role in the process of hydration of cement pastes. During the early stages of hydration, reaction of the aluminate phase (C_3A) with calcium-sulfate, yielding ettringite, prevents the occurrence of the undesirable effect known as "flash-set". On the other hand, formation of ettringite during late stages of hydration, which commonly occurs in heat-cured pastes, induces the build-up of dilative stresses that may ultimately lead to severe cracking within the matrix and at the interface with aggregates. Therefore, investigating the rates and modes of ettringite formation, and its spatial location and local abundance within the paste, is crucial to understanding both early-stage kinetics and processes related to deterioration.

In this study, a 3D non-invasive technique based on computed micro-tomography, coupled with X-ray diffraction (XRD-CT) is developed with the aim of mapping the distribution of ettringite within a cement paste. The main advantage of this technique is that the spatial distribution of ettringite (or other phases) can be studied on a three-dimensional basis, and without perturbing the microstructure of the sample. The output of the tomographic reconstruction consists of a series of 2D slices in which the relative amount of ettringite is encoded as a grey intensity value. A strategy was devised in order to convert the grey intensity values into volume fractions of ettringite, by calibration with the overall weight fractions relative to the various phases, obtained by Rietveld refinement of the diffraction patterns acquired by XRD-CT. Moreover, analysis of the images by a multifractal technique provided a tool for quantitative comparison of the ettringite distribution patterns in different samples, e.g. collected at different hydration times, or in OPC pastes with and without admixtures. The results of the multifractal analysis may also provide information about the modes of ettringite growth and aggregation during hydration.