Geophysical Research Abstracts
Vol. 13, EGU2011-6110, 2011
EGU General Assembly 2011

Non-destructive analyses of carbonate rocks: applications and potentiality for museum materials

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Carbonate rocks (calcirudites, calcarenites and calcilutites) have been commonly used in the past in the manufacturing of sculptures and stone artifacts, also in South-Eastern Sicily where carbonate rocks crop out in several formations in the Hyblean area. The preciousness of these historical artifacts forces to perform non-destructive and/or micro-destructive analyses especially when the archeological finds are held by museums. In particular, traditional invasive techniques such as optical microscopy, X-ray diffraction, and X-ray fluorescence, cannot be employed for the analyses of important museum materials whose provenance has not been clarified by previous archeological studies. An alternative and helpful technique for the reconstruction of chemical compositions of these materials is represented by the mobile XRF Spectrometer, which is significantly useful as no sample preparation is required, no alteration of the material occurs, the instrument is portable and the measurement time is short. In this work, we performed chemical analyses by means of portable XRF (Alpha 4000, Innov-Xsystems), for the study of carbonate rocks cropping out in the Hyblean area and belonging to several formations (i.e. Pleistocene calcarenites, Monti Climiti, Palazzolo and Ragusa). The analyzed samples are characterized by similar chemical features with CaO and $CO_2 > 35$ wt% and subordinate SiO_2, Al_2O_3 and Fe_2O_3contents. Amongst trace elements, Strontium, linked to carbonates, is clearly the most abundant with respect to the others elements. Chemical data have been further processed by means of multivariate statistical analysis: in particular, principal components analysis (PCA) and discriminant analysis (DA) allowed to classify the samples across the different Formations and to distinguish different rock typologies within each Formation.