The importance of the "natural background" determination in sediment management: geochemical and mineralogical approach

Daniele Are[1], Tiziana Busà[1]

[1]SELC Soc. Coop. – Società per l'Ecologia delle Lagune e delle Coste,
Via dell'Elettricità 3/d, 30175 Marghera-Venezia, Italy

Phone: +39-(0)-41-5384817
E-mail: are@selc.it

Introduction: Chemical and mineralogical knowledge of dredged sediment assumes primary importance for its correct management. The current regulation [1] requires the respect of correct values of concentration in establishing the sediment quality. From this point of view, the "natural background" determination becomes crucial to evaluate the natural concentration of heavy metals. A correct measure of the "natural background" implies a good knowledge of geological, stratigraphic and hydrological characteristic of the hydrographic basin. The mineralogical and chemical composition of the sediment is strongly related to the composition of the rocks outcropping upstream the depositional basin.
In the framework of studies performed in the last years for the Ministry of Infrastructures - Venice Water Authority, through its concessionary Consorzio Venezia Nuova, the background values of Venice Lagoon sediments were determined.

Methods: Statistical method is indicated by Italian rules [2, 3] as the methodology to determine anthropic and natural background. Metal and metalloid contents of a significant number of samples (20-30) are compared using statistical tests. Samples need to be collected in an area with the same lithological characteristics and upstream of the pollution source. In order to define this area, a good knowledge of geology and hydrogeology is required. Statistical method is applied to samples with the same lithology and collected at the same depth.
An alternative method to determine "natural background", experimented by our team in collaboration with the University of Padua [4], is based on geochemical and mineralogical approach. For the collected sediments, fractions of clay (<2μm) silt (63-2μm) and sand (>63μm) are separated. The whole sediment and each fraction are analysed by means of X Ray fluorescence. Clay and silt fractions are analysed by X Ray diffraction in order to determine the mineralogy and any possible presence of clay minerals. Sandy fraction is subjected to gravimetric separation: light minerals (es. quartz, feldspars, carbonates, micas) are separated from heavy ones (magnetite, apatite, olivine). Finally, magnetic separation is used to pull the ferromagnetic fraction apart from the paramagnetic and diamagnetic ones. Each fraction is observed through optical microscopy, in order to determine the mineralogical composition. Finally, leaching tests are used to determine which quantity of a specific metal or metalloid is released from the solid phase into the water phase. The comparison between chemical and mineralogical composition, supported by leaching tests, allows the real origin of metal or metalloid to be determined, and eventually the amount of it due to inorganic pollution.

Results and Discussion: Geochemical and mineralogical approach was applied to Venice Lagoon sediments. In particular Cr and Ni content are considered [4, 5, 6].

Cr content in the whole sediment = 80 ppm								
1			**2**			**3**		
Sand %	Silt %	Clay %	Sand Cr ppm	Silt Cr ppm	Clay Cr ppm	Sand Cr* ppm	Silt Cr* ppm	Clay Cr* ppm
60	36	4	98	40	165	59	14	7

Fig. 1: Cr contribution calculation in the three fractions: 1-Weight % for each fraction 2-Cr content in each fraction; 3-Cr contribution for each fraction.

In Fig. 1 Cr contribution calculation in the three fractions points out sand as the major responsible of Cr content in the whole sediment. Mineralogical analysis evidences that in sand fraction Cr and Ni are concentrated in the heavy one and in particular in garnets, amphiboles, pyroxenes and Fe-Ti oxides. In these minerals Cr and Ni are strongly bound inside the lattice, and they are not released in the environment. The geochemical and mineralogical approach, compared to statistical methods, provides the determination not only of metal or metalloid content in "natural background", but also the indication of which minerals contain them.

References: [1] D. Lgs. 152/2006 ; [2] Provincia di Milano (2003); [3] APAT & ISS (2006); [4] Jobstraibizer et al. (1995) *Plinius* **14**:181-182; [5] Are & Carlin (1994) *Studi Geologici – CVN;* [6] Jobstraibizer et al. (2004) *Studi Geologici – CVN.*