

Sediment at the sinking site of the ancient ship (Gnalić, Biograd na Moru, Croatia) as a centuries-old mercury source in the marine environment

Željko Kwokal¹, Vlado Cuculić¹, Neven Cukrov¹, Irena Radić Rossi²

¹Ruder Bošković Institute, Division for Marine and Environmental Research, Bijenička cesta 54, Zagreb, Croatia Phone: +385-(1)-4561-190

E-mail: cuculic@irb.hr

²University of Zadar, Department of Archaeology, Ulica Mihovila Pavlinovića 1, Zadar, Croatia

Introduction: At the end of 16th century, on its way from Venice (Italy) to Constantinople (Istanbul, Turkey) a large merchantman was lost near Islet of Gnalić, Biograd na Moru, Croatian Eastern Adriatic coast (Fig. 1). Mercury ore cinnabar (HgS), vermilion powder and elemental mercury (roughly estimated between 500-1000 kilograms) were found among various types of merchandise of ship's cargo. It is assumed that these mercury forms have been used for medical and cosmetic purposes [1]. The sunken ship was discovered in the 1960s, and the first detailed and systematic measurement of mercury at a sinking site (depth of 25 meters) and its vicinity began in 2013.

Methods: Sediment samples were taken between and after excavation seasons from five places to a depth of 10 centimeters by scuba diving technique. After drying, non-fractionated sediments were digested with a mixture of nitric, perchloric and hydrofluoric acid. Mercury analyses were carried out by cold-vapor atomic absorption spectrometry (CVAAS) method with detection limit of 0.001 microgram per gram for solid materials [2].

Results and discussion: The measured concentrations of total mercury are on average two orders of magnitude higher compared to concentrations in predominantly unpolluted sediments of Eastern Adriatic [3].

The presence of dissolved gaseous mercury in the surface of the water column (25 meters) above sinking area at concentrations up to thousand times that of pristine sea water clearly shows that mercury in sediment is a source of emanation of different mercury species into aquatics with possible different consequences.

References: [1] Radić Rossi & Castro (2012) *Histria Antiqua* **22**:365-376; [2] Martinčić et al. (1989) *Sci Total Environ* **84**:135-147; [3] Cuculić et al. (2009) *Estuar Coast Shelf Sci* **81**:311-320.

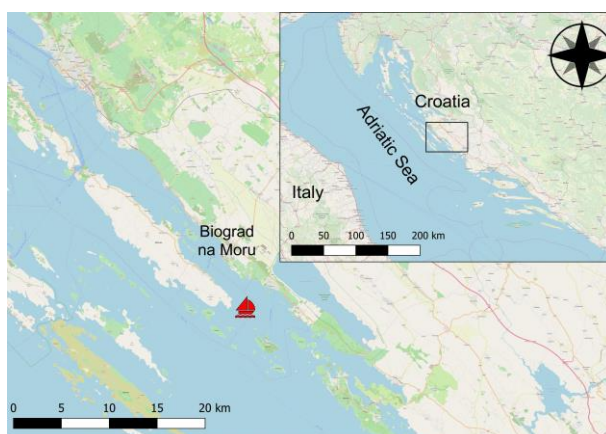


Fig. 1: Location of the sinking site.