

## **Discharge measurements based on tracer dilution method applied to the hydrogeological study of karst springs in the Mount Albo area (Sardinia NE)**

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### **ABSTRACT**

This study is focused on the main spring of the karst aquifer of Mount Albo situated in the area of Siniscola, in the province of Nuoro (Sardinia NE). It was developed for the sustainable management of groundwater resources in accordance with current laws: Law n. 183/89, Law n. 36/94 and by Legislative Decree n. 152/2006. The Groundwater of Mount Albo's aquifer is a great relevance resource for the territory and requires studies and safeguards to preserve its quality and quantity. Mount Albo is a mountain chain elongated for about 30 km along the main direction NE-SW and it's formed by middle Jurassic to lower Cretaceous Limestones and Dolostones, that have been intensely karstified. The aquifer is confined at the base and sideways by the Hercynian Metamorphic Basement. The principal aim of this study was to develop a methodological approach to discharge measurements with the use of tracers. Discharge measurements were performed to improve the knowledge of the karst aquifer. This survey was also used to produce a preliminary rating curve peculiar to the main karst spring of Fruncu 'e Oche in the northeastern part of Mount Albo. Tracer Dilution Method for stream gauging, known since 1863 (Spencer and Tudhope, 1958), has been used with both chemical and radioactive tracers. This technique has increased significantly after the development of fluorescent dyes (Kilpatrick and Cobb, 1985). Recently it has been successfully applied both with saline tracers (Moore, 2004) and with Fluoresceine (Dahlke, 2014; Schnegg et al., 2011). In this survey we have conducted discharge measurements with the tracer dilution method. This procedure consists in the injection of a tracer solution at a specific point upstream and in the measurement of its dilution in the water flow at a known point downstream with field sensors. Tracers used were salt (NaCl) and Fluoresceine dye, also known as Uranine. We used the following Injection techniques: Slug Injection and Constant Injection. In the first method a specific mass of tracers is poured at once into the stream and it is based on tracer's total recovery principle according to which the mass injected into the stream at the injection point must flow all through the measuring point downstream without tracer losses. The second technique, based on the achievement of the steady state, consists in the constant rate injection of tracer solution into the stream by making use of a Mariotte Bottle. Different sensors operated to detect the tracer and register the related time-concentration curve. STS Multi-parametric sensors were used for the saline tracer measurement, Sommer Messtechnik sensors and GGUN-FL-30 fluorometric sensors were used for Fluoresceine. During the observation period 69 discharge measurements were performed with the tracer dilution method; most of them were obtained with the Slug Technique (Fig.). The least used method was Constant Injection because of some complications in the achievement of the steady state due to low turbulence and water turbidity. Therefore, the results observed with the slug injection technique using salt and Fluoresceine tracers

have been compared. Regarding to the medium value as the most accurate, a relative error of less than 2% occurred among these results due to the lack of an absolute reference value. To conclude, despite non-ideal conditions and the relative error, the discharge measurements obtained can be considered more accurate than a merely visual estimation and confirm the good reliability of this method. In the future, the implementation of a weir for continuous flow measurements will allow a more refined approach to the dilution method for stream gauging with the estimation of absolute error.

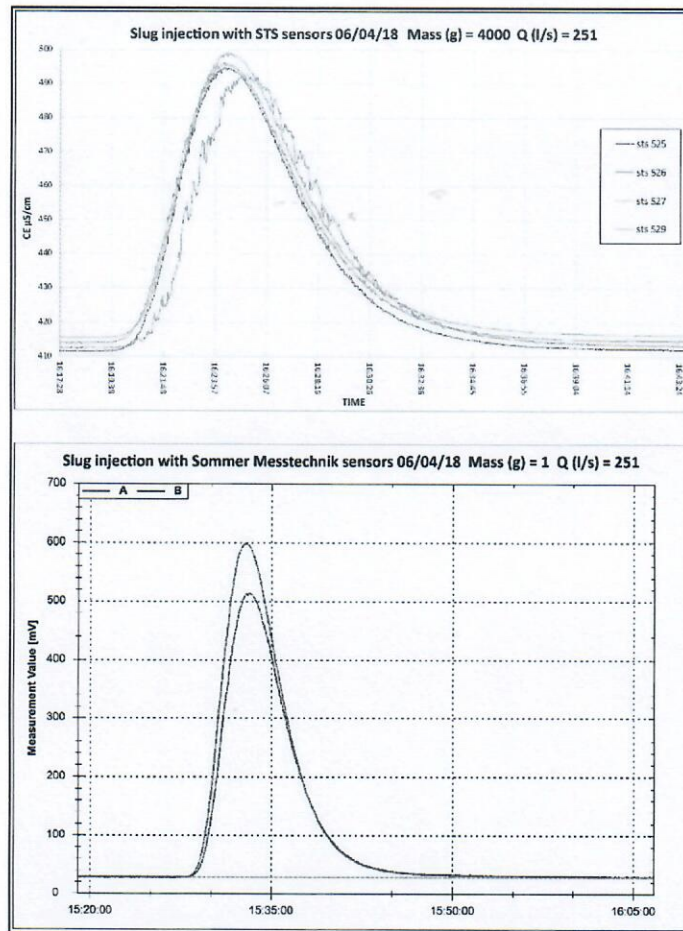


Fig. 1 - Examples of Slug Injections graphs with saline tracer and Fluoresceine dye

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