# Notes on submarine springs

*by*

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Submarine springs are a phenomenon distributed all over the world. They are well known since Greek and Roman times, but they have been forgotten by scientists so far. The increasing need for water supply has brought up a new interest for these completely unexploited natural resources.

Underwater springs are recorded almost in every part of the world. In the Mediterranean basin they are known on the coasts of France, Spain, Algeria, Lebanon, Turkey, Greece, Yugoslavia and Italy. In the Black Sea they are known on the Rumanian coasts. Underwater springs can be found where an aquifer is outcropping on the bottom of a water basin or, much more frequently, where karst passages have their exit. At present the only way to recognize a spring is to detect on the surface the typical circular mark made by the upwelling spring waters. This surface evidence takes place only where a fresh or brakish water spring is outflowing into the sea. This because the spring water is upwelling only by its lower specific gravity in regard to the environment. Therefore there will be no such surface evidence for these springs which outflow into a water body with a specific gravity equal or lower than their waters. From the springmouth on the bottom, the fresh or brakish water arrives directly at the sea surface in a form of a vertical column funnellike shaped. It looks like a whirl wind cloud and it sometimes has some turbulence of the same type.

A research project has been carried out in order to study the phenomenon of submarine springs and to capture them. In order to take underwater measurements of the spring parameters, as water quality, temperature and outflow, a new technology has been developed, since there were very few gears on the market, ready to be used for such purposes underwater and inside the springmouths. This has been a necessity because the only way to study these springs is to become a diver, to go underwater and work. In order to facilitate the sampling, the spring water has been brought to the surface with a pipeline inserted in the mouth and supported by a buoy. The equipment has survived very strong storms through a special mooring system, with differential action. The spring water reaches the surface within the pipe because of its lower density in comparison with the seawater. The spring water rise is simply regulated by the Archimedes law and the pression which causes the spring to outflow has but a neglectable influence. Its height inside the pipe on the sea surface can be determined with the formula :

$$h = \frac{D\,(\S s - \S w)}{\S w}$$

where :

D = spring depth
§s = sea water specific gravity
§w = water specific gravity inside the pipe
h = spring water height reached inside the pipe above sea surface.

The research carried out so far has evidenced how pollution of the spring water caused by mixture with sea water usually takes place inside the spring mouth. In order to avoid these mixtures causing water pollution, it has been decided to put on the spring mouth a bell with a syphon which eliminates the possi-

*Rapp. Comm. int. Mer Médit.*, **21**, 5, pp. 273-275 (1972).

bility for the seawater to enter and pollute the spring. Almost the same arrangement will be used when the springs will be exploited. The production pumps will be connected directly to the syphon, and the amount of the water pumped out should be exactly the same as given by the springs. Any increase or decrease of the pumping rate will cause the seawater to enter the conducts or the spring water to be wasted into the sea. Inside the descending part of the syphon some salinity transducers will automatically regulate, through electronics, the pumping rate.

The first experimental capture of a submarine spring is at present being carried out by us in the Mar Piccolo at Taranto, southern Italy. A fiberplast bell has been fitted at the mouth of a submarine spring at a depth of 19 meters. Acting on the different exhaust valves of the bell it will be possible to reproduce the conditions of exploitation of the spring, and to take good measurements of the different spring parameters. The latter will be also continuously and automatically recorded on magnetic tape cassettes. The data, ready to be processed by computer, will give us the first information of submarine springs behaviour.

The work carried out so far has evidenced several new important factors controlling underwater springs. We hope that our research, in the proceedings, will help to solve the water supply problems of several coastal areas lacking in surface waters, where a karst hydrology wastes into the sea large amounts of valuable, needed water.

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