The submarine springs of fresh water and the problems of their capture

by

FLORIANO CALVINO* and ANTONIO STEFANON**

**Sezione geologica del Centro di studio per la geologia e la petorgrafia del C.N.R. presso l'Istituto di geologia dell'Università, Padova (Italie)*

***Centro nazionale di studi talassografici del Consiglio Nazionale delle Ricerche, Venezia (Italie)*

Submarine springs are very frequent all over the world. They are known in the Persian Gulf, in the states of New York, Florida and California, the Bahamas and Barbados, Cuba and the peninsula of Yucatan, Chile, Hawaii, Samoa and Guam, Australia and Japan. In the Mediterranean area they are known off Libya, Israel, Lebanon, Syria, Greece, Yugoslavia, Italy, France and Spain. There is some unconfirmed information about large submarine springs also along the Roumanian coast of the Black Sea.

Most frequently they discharge cold, fresh water, but there are also some other submarine springs of brackish or thermal water. They are most frequently associated with karst geology of the limestone or dolomite regions, though there are also a few springs distributed along submarine outcrops of confined aquifers.

At the recent Symposium on Hydrology and Water Resources, held at Ankara, Mr. Kohout of the U.S. Geological Survey pointed out that only fifteen scientific studies had been carried out so far all over the world on that common, yet somehow neglected phenomenon. As regards the efforts to capture such water, he remarked that not much greater progress has been made in this field, since the age of the Phoenicians. This people drew their fresh water from the springs along the sea bottom, by covering the mouth of the springs with lead funnels ending in leathern tubes.

One cannot possibly overemphasize the economic importance of submarine springs, which are frequently located along the coasts of arid lands. Furthermore, the increasing population concentration along the coastlines of the world will bring about a demand for fresh water perhaps exceeding the inland fresh water supply; thus, in the near future, these submarine fresh water resources, so far untouched, will have to be exploited.

There are two main methods of water capture considered practical at present to solve this problem : one is the interception of the aquifers or karst channels by wells; another is the direct capture of the springs. The former method, based on careful geological studies, is suitable for the exploitation of continuous aquifers. This method, however, is difficult and risky to apply in the most frequent case, which is the underground water flow through karst channels. In such case a better suited technique would be to try covering up the water orifices with watertight bells, fastened to the bottom. These could be connected by a pipeline to the shore. Even this method has some disadvantages. Apart from the difficulty of protecting the installation from wave action during the storms, there exists always the danger that the fresh water, because of the increased drag within the installation, may gradually find and enlarge some other exit. It may, for instance, increase the outflow from the secondary sources, which generally exist near the major ones. There is also the possibility, during a flood flow, that the temporary high pressure may be capable of causing serious damage to the installation.

In Italy we have been interested in submarine sources for some years. These are known to exist in the Gulf of Trieste, Gulf of Taranto, in Lucania, near Capri, in Sardinia and Liguria. In 1963 we published a hydrogeologic study on the group of karst-type springs off La Mortola, near the French-Italian border. The investigation has been carried out also by diving research. The largest of these sources has a discharge of about 100 liters per second, possibly more, and lies at a depth of 39 m.

Rapp. Comm. int. Mer Médit., **19**, 4, pp. 609-610 (1969).

We have presented a research program, which is now submitted to the Consiglio Nazionale delle Ricerche. Temporary capping and discharge measurements from a ship should be effected for all the springs off La Mortola. We have also planned the construction of an experimental, somewhat more permanent capping (for about 3 years) installation. The pipeline would stretch to the shore and recordings of the hydrologic parameters could be thus made. In this work we think one should employ a team of experienced divers, since nowadays the special techniques and tools of underwater work have attained a high degree of effectiveness and economy.

We plan to place around the irregular fresh water exit a short, stiff cylinder, serving as a base for a flexible, mobile equipment. The latter would be installed whenever the necessity for taking hydrologic measurements arises. Such measurements would be effected on the fresh water flow brought aboard a ship by a pipe. The experimental, permanent capping will be restricted to the most important spring. The effect of this capping on the secondary springs will be checked through observation of their discharge. For a more permanent installation on the main spring we plan to use a metal case, about 8 m by 5 m, buried in concrete, with a plastic pipeline of about 1,000 m in length, capable of handling even some of the flood conditions. Thus the amount of flow and the magnitude of floods would be measured and recorded continually.

From the experience obtained during the three years' work, measurements, and analyses, we expect to be able to draw the necessary conclusions to plan the rationale of a final installation of direct, submarine capping. This would be the first effective capping in the world and could serve as a model for similar future works.