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ROCK TYPOLOGY IN CHOOSING SPRINGS. ANCIENT METHODS FOR DETERMINING WATER QUALITY IN THE PARMA REGION

LES TYPES DE ROCHES UTILISÉS DANS LA SÉLECTION DES SOURCES D'EAU. ANCIENNES METHODES POUR DETERMINER LA QUALITE D'EAU DANS LA REGION DE PARME

LA TIPOLOGIA DELLE ROCCE PER LA SCELTA DELLE SORGENTI. ANTICHI METODI PER DETERMINARE LA QUALITÀ DELLE ACQUE NEL PARMENSE

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Summary

This study was a scientific validation of some ancient methods used for purifying water and selecting springs based on the nature of the soil and rocks. A historical and scientific analysis of the territory was made, with the aim of trying to identify ancient methods which might be retrieved and used again in a modern way for a comprehensive interpretation of the environment we live in. The investigation was led near Parma in the north of Italy, in mountainous and hilly areas which rise from rocky outcrops consisting of fragments of the ancient oceanic crust composed of argillaceous complexes, ultrabasic rocks from the ophiolite succession as well as flyschoid sedimentary rocks containing arenaceous, carboniferous and marly elements.

Key Words: *ophiolite, clay, marly rocks, springs, water quality, popular culture in the Parma region.*

Résumé

Cette étude vise à vérifier, d'après les principes scientifiques, les méthodes anciennes utilisées pour la purification de l'eau et la sélection des sources basées sur la nature des sols et des roches. Ces travaux constituent une lecture historico-scientifique du territoire, afin de chercher à identifier les méthodes anciennes qui peuvent être récupérées, et de les actualiser dans l'environnement moderne mondial dans lequel nous vivons. L'enquête a été menée dans les stations de montagne et de collines de la région de Parme qui se dressent sur des affleurements de roches formées des fragments de la croûte océanique ancienne composée d'argiles complexes, de roches ultrabasiques de la succession ophiolitique et de roches sédimentaires flyschoïdes arénacées, carbonatées et marneuses.

Mots-clés: *ophiolites, argiles, roches marneuses, sources d'eau, qualité des sources d'eau, culture populaire dans la région de Parme.*

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Riassunto

Questo studio si propone di verificare, in chiave scientifica, gli antichi metodi applicati per la depurazione delle acque e la scelta delle sorgenti, basati sulla natura del suolo e delle rocce. Lo scopo del lavoro è volto ad una lettura storico-scientifica del territorio per cercare di individuare i metodi antichi da recuperare e ri-proporli in chiave moderna per una lettura globale dell'ambiente in cui viviamo. L'indagine è stata svolta nelle località di montagna e di collina parmensi che sorgono sugli affioramenti di rocce costituite da frammenti dell'antica crosta oceanica, costituita da complessi argillosi, rocce ultrabasiche della successione ofiolitica e da rocce sedimentarie flyschoidi contenenti elementi arenacei, carbonatici e marnosi.

Parole chiave: *ofioliti, argille, rocce marnose, sorgenti, qualità delle acque, cultura popolare parmense.*

Introduction

In parallel with technological evolution, human ecosystems have developed as systems of relationships between the natural environment and the populations who dwell in a specific territory. From the second half of last century onwards the socio-economic tendency has been to expect an ever greater amount of energy from the environment to satisfy demands of health and wellbeing (Moroni, 1986).

With the passing of time, the relationship Man/environment, after remaining stable for many centuries, has changed in just a few decades from a natural equilibrium to an imbalance in the entire ecosystem. At present, we are living through a cultural transition phase between ecological crisis and the launching of projects to re-establish environmental balance. Consequently, in this passage there is a far greater risk of losing the cultural link between the ancient methods used for water purification, currently entrusted to the fleeting memory bank of the elderly, and new expertise aimed at prevention and the setting up of production processes which use Clean Technology.

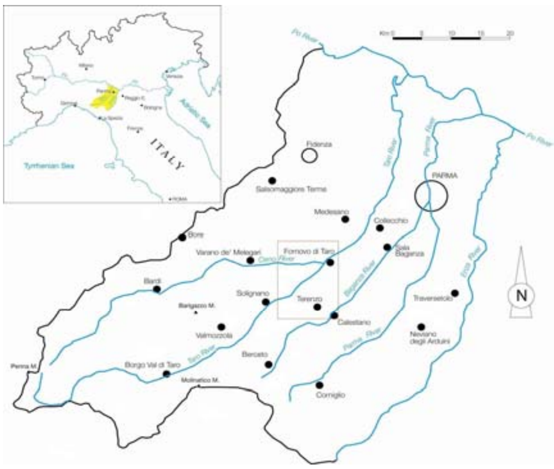

Figure 1

Index map

The relationship between living being and environment begins with exploitation of natural resources, starting off with the geological and geo-morphological elements offered by a territory: such as, for example, that of the foothill area of the province of Parma (Fig. 1) which features ophiolite consisting in peridotites and serpentinites (Saccani, 2002; Vernia, 2001; Pagani et al., 1972) and rocks mainly of a sedimentary nature of marine origin (Zanzucchi, 1980 and others), used since time immemorial for the anthropic activities of the area.
Locally, in the hills and mountains, the quality of the waters was identified in the springs which pour out of ophiolite complexes in contact with argillaceous formations and, subordinately, from those which emerge along the line of contact between permeable rocks (calcareous marly formations) with underlying clay, where the waters, running between the two geological formations become enriched with minerals. The watercourses in the area under investigation, distinguished by being steeply sloping, have encouraged the creation of methods to purify the waters by positioning riverbed barriers, or through the use of natural materials.

Materials, Methods and Results

The study was divided into several phases: from an analysis of the waters which flow from the ophiolites, carried out over the two years 2003-2004, to the gathering of evidence by personal interview.
The area of the investigation was limited to the hilly and mountainous area surrounding the built up area of Fornovo di Taro (Province of Parma), where there are ophiolite ferrous <snouts> and springs (Andreozzi and Zanzucchi, 2007).
The analytical assessments of the waters were: a) of a chemical-physical character (temperature, pH, conductivity); b) volumetric (hardness, oxidability (Kubel), dissolved oxygen and percentage of saturation, chlorides, BOD5); c) spectrophotometric (calculation of ammonia, nitrates, phosphates and iron); d) microbiological (search for E. coli and total coliforms) (Table 1).

Parameters		Sample 14.05.2003	Sample 20.04.2004
Temperature	°C	15	12
pH 20 °C		8.0	7.95
Conductivity	MS/cm	383	300
Hardness	°F	11.8	4.9
Cl^-	mg/l	5.6	2.1
O_2	mg/l	9.3	9.3
% saturation		103	86
Oxidability (Kubel)		1.33	0.74
BOD_5		2.3	2.2
NH_4^+	mg/l	0	0.01
NO_3^-	mg/l	0	0
Fe^{2+}	mg/l	0	0
Total bacterial load		0	0
Faecal coliforms		0	0
Total coliforms		0	0

Table 1

Chemical-physical and microbiological characters of waters

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The analytical methods were drawn from CNR-IRSA (water research institute) and carried out in the laboratories of ITSOS “Carlo Emilio Gadda” at Fornovo di Taro (Gesmundo et al., 2004)

Discussion

The mineralogical content of the ophiolite outcrop of Monte Prinzera (Fig. 2); predominantly consists of olivine (circa 62% in volume), orthopyroxene (circa 25% in volume), clinopyroxene (circa 10% in volume), spinel (circa 3% in volume) and, occasionally, amphiboles (Beccaluva et al., 1973; Piccardo et al., 1990; Venturelli, 2001).

The waters which infiltrate through the fissures in the ophiolite, rich in iron and magnesium because of their "magmatic" origin, run in large channels and percolate through the fissures giving rise to numerous layer-springs, which emerge along the line of contact between a permeable rock and an impermeable one beneath it.

Figure 2

Panoramic view of the ophiolite outcrop of Monte Prinzera. (44° 38’ 30’’ N and 10° 5’ E)

The basic pH and the scarcity of cations of sodium and calcium (contained in the clinopyroxene) agree with a typical situation of water flow through rocks with a high ferromagnetic component, typical of ophiolite rocks. The basic pH, in the springs under examination, can reach high enough values to saturate the serpentine (Venturelli, 2001):

$3\ Mg_2SiO_4 + H_4SiO_4 + 2\ H_2O = 2Mg_3\ Si_2O_5(OH)_4$

$3Mg_2\ Si_2O_6 + 8\ H_2O = 2Mg_3\ Si_2O_5(OH)_4 + 2H_4SiO_4$

$3CaMgSi_2O_6 + 13H_2O = 3Ca^{++} + Mg_3Si_2O_5(OH)_4 + 4\ H_4SiO_4 + 6OH^-$

According to the regulations in force, the spring belongs to class A1, and to be 100% potable it would be sufficient to filter it.

In this way the water is enriched with minerals and, thanks to its ferromagnetic properties features a limited amount of cations of sodium (6.5 mg/l) and calcium

(10.2 mg/l), while the presence of magnesium (34.0 mg/l) and bicarbonate (188.0 mg/l) makes the water light.

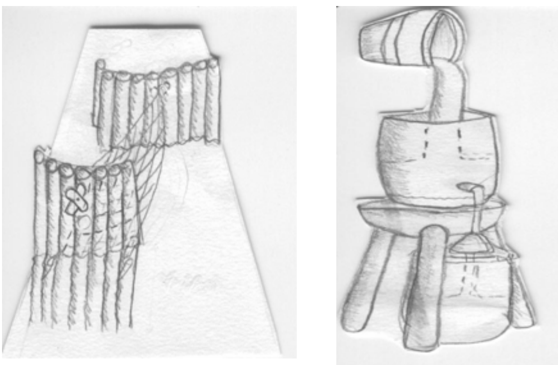
Instead, in the absence of ophiolite rocks water purification techniques have involved calcareous marly rocks, particularly abundant in the Parma Apennines in general and in the area under examination (Zanzucchi, 1980; Andreozzi e Zanzucchi, 2007)

The abundance of these rocks locally has led to their use for the production of quicklime, employed for various water purification techniques, thanks to its property of raising the pH and temperature of the water. Quicklime is obtained by cooking limestone which, at temperatures greater then 900 °C, leads to the formation of calcium and magnesium oxides:

$CaCO_3 = CaO + CO_2$ or $MgCO_3 = MgO + CO_2$

With the addition of water, from these oxides is obtained "calcium hydroxide", through the "slaking" reaction: $CaO + H_2O = Ca(OH)_2$

Figure 3 - *River bed barrier, filtering and use of quicklime (drawing by Giada Adorni). Instead, to reduce the microbial load (personal testimony by Enrico Cenci) the following procedures were used:*
A - Water was taken from the stream, boiled from 30 minutes to 1 hour, and then poured into bottles to cool before being used.
B - Water from a well was left in an ice-box for 3 days and then, once thawed, put into kegs (of wood or iron) and poured from these into glass bottles.
C - Water drawn from a well was poured into a cauldron, and 50 grams of fossil carbon was added. Subsequently, the water was sieved to eliminate the fossil carbon and poured into a bottle. It was then poured back into the cauldron and the whole operation was repeated. At the end the water was poured back into the glass bottles ready for use.



A) B) C)

The ways of using lime may be summarised as follows (Fig. 3):

A - In summer, when the water level did not exceed 20-30, wooden piles were inserted into the riverbed (1-1.5 metres high) positioned side by side to form a curved fence (circa 2-2.5 metres long).

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B – After an initial filtering, the water was collected in a barrel with a tap positioned higher than the base. The remaining debris was deposited overnight.
C – The water was poured into a barrel on top of a stool high enough to be able to place another barrel underneath it. Then a tap higher than the base was opened, so that the debris did not remain in the water. The water coming out of the tap was allowed to run through quicklime lying on top of a piece of cloth supported by four hooks and was then poured into another barrel and filtered through further hooked pieces of cloth. At that point the water was ready to be decanted into glass bottles.

Conclusion

The methods assessed by this study, especially those used in times gone by to identify the goodness of spring waters from ophiolite rocks, reflect real quality in the springs analysed.

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