REFLECTION ABOUT HIGH MOUNTAIN KARST ENVIRONMENTS AND THEIR FRAGILITY IN THE DOLOMITES

RAZMIŠLJANJE O VISOKOGORSKEM KRASU DOLOMITOV IN NJEGOVI RANLJIVOSTI

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Abstract UDC 504.06:551.44(234.323.33)

Meneghel, Mirco & Sauro, Ugo: Reflection about high mountain karst environments and their fragility in the Dolomites*

In the plateau areas of high mountain in the Dolomites between two and three thousand meters in elevation, karst landforms are well developed and in general the interference between glacial and karstic processes with development of a typical glaciokarstic relief is clear. In the past these areas were visited by very few people as hunters of chamois or as shepherds. Today is impressive the frequentation of high dolomitic mountain by excursionist and skiers. Modifications induced by human frequentation and use of these extreme environments are heavy. From 1983 some few aspects of chemistry of waters in relation with well differentiated microenvironments in the Pale di San Martino have been investigated.

Izvleček UDK 504.06:551.44(234.323.33)

Meneghel, Mirco & Sauro, Ugo: Razmišljanje o visokogorskem krasu Dolomitov in njegovi ranljivosti

V Dolomitih so na planotah v višinah med 2500 in 3000 m visokogorske kraške oblike dobro razvite in običajno je na tipičnem glaciokraškem reliefu razmerje med glacialnimi in kraškimi procesi jasno vidno. V preteklosti so ta področja obiskovali le redki lovci na gamse in pastirji. Danes pa so izletniki in smučarji v visokih Dolomitih izredno številni. Posledice množičnega obiska in izrabe tega izjemnega okolja so težke. Od 1983 so raziskovali nekatere kemijske lastnosti voda glede na mikroekološke razlike na Pale di San Martino. Odnos različnih kemijskih parametrov je podan na slikah 1 in 2.

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A characteristic feature of high mountain in the Dolomites is the presence, between two and three thousand meters in elevation, of large plateau surfaces. These plateaus are linked both with the structural control, in particular with the frequency of subhorizontal bedding of the carbonate sedimentary sequence, and also with the presence of erosional surfaces developed during the complex orogenetic and morphogenetic history of the region. This feature makes the high mountain area quite extensive in comparison with other alpine regions.

In the plateau areas, high mountain karst landforms are well developed and in general the interference between glacial and karstic processes with development of a typical glaciokarstic relief is clear. Here the vegetation cover is scarce or absent and, especially above the elevation of 2500 meters, the scenery is that of a stony desert. At lower elevations the bottoms of glaciokarstic depressions often represent small oasis, which lodge isles of meadow soils and small lakes sometimes. A common opinion about the high mountain karstic desert areas is that they don't represent peculiar environments worthy of protection. So they may be destroyed by everybody for every purpose without any control.

In the past these areas were visited by very few people as hunters of chamois or as shepherds. In the first half of this century some hydro-electric plants were developed also in high mountain karst regions. Notwithstanding this, no dams were built on the plateau, but only in the valley bottoms. Systems of galleries were built to connect reservoirs, which crossed also important underground karst cavities.

Today is impressive the frequentation of high dolomitic mountain by excursionist and skiers. According to WALTER in 1989 the overnight presences of tourists in the villages of Dolomites were 56 millions; the number of arrivals was 6 million (average stay of about 10 days); the total number of passenger cableways, chair lifts and ski-lifts is 470; the number of ski tracks where the slope surfaces were artificially remodelled is of many hundreds; the number of snow shooting cannons in the past winter was about 1000 (and some use additives as Ammonium nitrate). Beside this there are hundreds of high mountain equipped tracks and hundreds of alpine huts and bivouacs.

Modifications induced by human frequentation and use of these extreme environments are heavy: increase of the erosion on the slopes, waste waters of the alpine huts in karst networks, solid waste disposals near the huts and along the most frequented tracks. In the summer of 1988 "Mountain Wilderness" promoted a cleaning operation of the southern slope of Marmolada, the highest of the dolomitic mountains. Many impressive photographies were taken on wastes and some hundreds of sacks were piled. On the same occasion was denounced the fact that, to make the ski less dangerous, in the northern slope of Marmolada some crevasses of the glacier had been filled with sacks of expanse polythene.

PROBLEMS OF ENVIRONMENTAL RESEARCH IN HIGH MOUNTAIN KARST ENVIRONMENT

The first impression for an excursionist in a high mountain karst area is that in it there is no life, or very simple life forms. The reality is that there are pioneer forms of life, which are not so easy to be detected and are bad known. The study of such pioneer communities may represent one of the next frontiers of environmental interdisciplinary research. The comprehension of the characters of the different groups of micro and small organisms from bacteria, to algae, to lichens, of the development of special communities and of their interactions may represent an important step for a better comprehension of the nature. Also the development of pioneer soils may be interesting.

So it is important to promote inter-disciplinary research to demonstrate that it is a false both that these environments are without interest and that they are undifferentiated. Finally it has to be studied the fragility of these environments. It is important to evaluate the possible influences of acid rains (some kinds of lichens are disappearing perhaps because of the acid rains), of the chemicals for the artificial snow, and of other forms of pollution on the pioneer communities. From 1983 we are engaged in a research programme devoted to highlight the geomorphological characteristics of the Southern Alps with a specific interest to the karst environments and karstic processes.

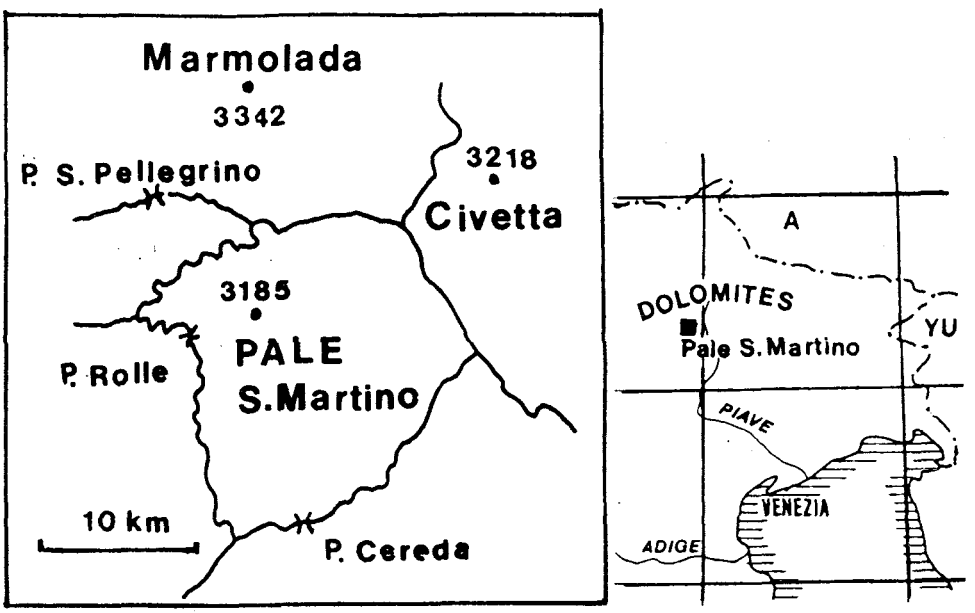

Fig. 1 Geographical position of Pale di San Martino
Sl. 1 Geografski položaj planote Pale di San Martino

SOME CHARACTERS OF THE WATERS IN THE PALE OF SAN MARTINO PLATEAU

In 1983 we investigated some few aspects of chemistry of waters in relation with well differentiated microenvironments in the Pale di San Martino. The Pale di San Martino is one of the highest dolomitic plateaus, between 2500 and 3000 meters a. s. l. (Fig.1)

The plateau is subject to a very wide range of changes during the annual cycle:

- 8 - 10 months with a snow cover and temperatures below 0°C; - some weeks with a large amount of water saturated in some positions (in many places the karstic absorption is made impossible because of the frost conditions of the epikarst);
- 2 - 4 months with semiarid conditions with a drastic daily cycle of temperature and humidity; temperature on the rocky surfaces may vary between below zero °C and some tens of degree above; humidity may also vary between saturation conditions during night to very dry ones during the day. These variations are wide also in the small water bodies as the filling ones of solution pans where the water may be frozen in the night and raised to temperature till to about 20°C during the day.

Five different microenvironments for water sampling were distinguished:

- snow melting waters very near to the origin;
- snow melting rills and lakes on the plateau;
- solution pans;
- small peat mosses;
- torrents and springs on the slopes.

The range of different chemical parameters is exemplified in the fig. 2. Low temperatures have been found only in snow melt waters and in the spring and torrents; the higher temperatures of the other environments are due to the fact that measures have been made during the day: here in the night a huge drop of temperature has to be expected. Waters are always basic and often very basic; only one measured snow melt water revealed a pH of 6.5. The low pH of the peat is probably due to biological activity. The total hardness vary from 17 mg/l in a solution pan and in a snow melt rill to 230 mg/l in a spring along the slope bordering the plateau. A hardness of 970 mg/l measured in an other spring of the same slope is probably due to gypsum layers crossed by the water in its underground run. Ca hardness contributes from 48% to 88% to the total hardness. CO_2 content is usually low; only springs and torrents in the slope show a content up to 20 mg/l.

Fig. 3 is a diagram showing total hardness against elevation. Here all the measurements have been put regardless of the microenvironment. A general increase of the hardness is clearly showed with decreasing elevation. Waters are enriched of carbonates at lower elevation because of longer paths in the ground and the increased biological activity.

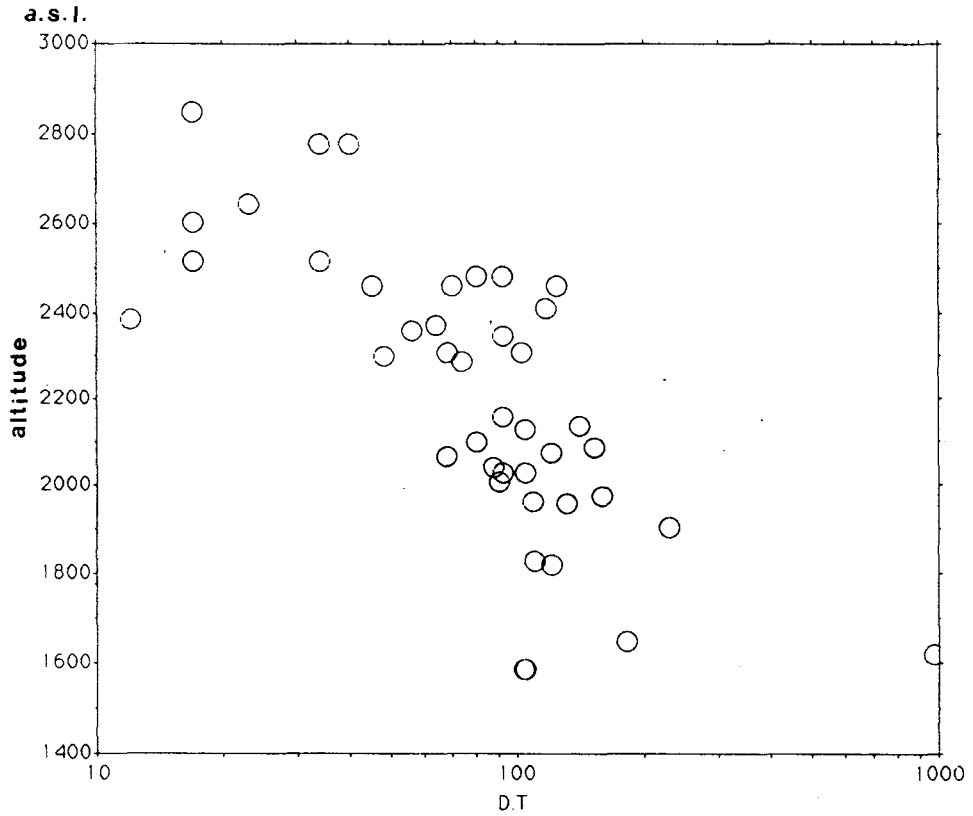

Fig. 2 Physical and chemical parameters measured in the waters of some microenvironments in the Pale di S. Martino dolomitic mountain. A - snow melt waters very near to the origin; B - rills and lakes on the plateau fed by snow melt waters; C - solution pans; D - small peat mosses, E - torrents and springs on the slopes bordering the plateau, TH - total hardness in mg/l of $CaCO_3$ (white rectangles - Ca hardness); CO_2 content in mg/l.

Sl. 2 Fizični in kemijski parametri, merjeni v vodah manjšega področja Pale di San Martino v Dolomitih. A - snežnica, zelo blizu izvora; B - škraplje in jezerca na planoti, ki jih napaja snežnica; C - kamenice; D - krpe mahovne šote; E - hudourniki in izviri na pobočju pod planoto; TH - celokupna trdota $CaCO_3$ v mg/l (beli pravokotniki - Ca trdota); vsebnost CO_2 v mg/l.

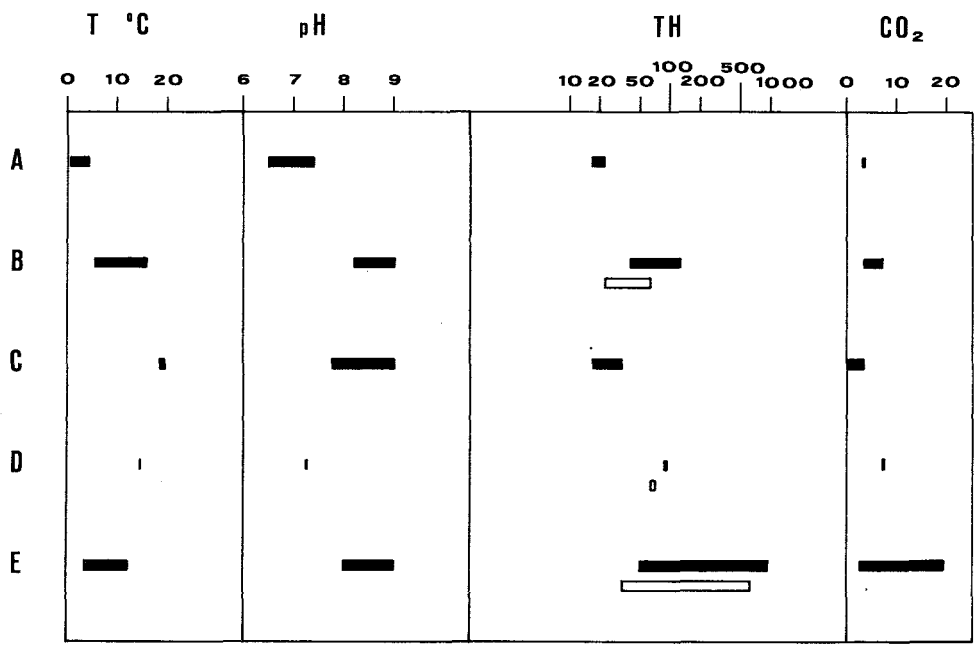

Fig. 3 Total hardness (in mg/l of $CaCO_3$) against elevation in metres. Horizontal scale is not linear.

Sl. 3 Celokupna trdota ($CaCO_3$ v ng/l) glede na nadmorsko višino. Vodoravna skala ni linearna.

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Povzetek

Prostrane planote na višini dva do tri tisoč metrov so značilne za visokogorski kras v Dolomitih. Visokogorske kraške oblike so dobro razvite in običajno je na tipičnem glaciokraškem reliefu odnos med glacialnimi in kraškimi procesi jasno viden. Vegetacije skoraj ni in zlasti nad 2500 m daje pokrajina videz kamnite puščave. V preteklosti so ta področja obiskovali le redki lovci na gamse in pastirji. V prvi polovici tega stoletja je zraslo tudi na področju visokega krasa nekaj elektrarn. Zgrajen je bil sistem cevi za povezovanje rezervoarjev, ki prečkajo pomembne podzemne votline. Danes pa je obisk izletnikov in smučarjev na visoke gore Dolomitov izreden.

Po podatkih WALTER (1990) je bilo v letu 1989 po naseljih v Dolomitih 56 milijonov nočitev; obiskovalcev je bilo 6 milijonov, skupno število žičnic, sedežnic in vlečnic je 470; število smučarskih prog, zaradi katerih je bilo površje umetno spremenjeno, je več sto; v zadnji zimi je delovalo približno 1000 snežnih topov. Poleg tega obstoja na stotine urejenih planinskih poti, koč in bivakov. Spremembe, ki jih povzroča množični obisk in izraba tega izjemnega okolja so težke; povečanje erozije na pobočjih, odpadne vode iz alpskih koč v kraškem podzemlju, gore odpadkov ob kočah in ob najbolj obiskanih poteh.

Od 1983 so raziskovali nekatere kemijske lastnosti voda na Pale di San Martino. Odnos različnih kemijskih parametrov je podan na sliki 1. Vode so običajno bazične, pogosto zelo bazične; samo en vzorec snežnice je imel pH 6.5. Razlog za nizek pH šote verjetno leži v biološki dejavnosti. Skupna trdota niha od 17 mg/l v kamenicah in škrapljah, do 230 mg/l v izvirih na pobočjih pod planotami. Vsebnost CO_2 je običajno nizka; le v izvirih in hudournikih na pobočjih je bila izmerjena vrednost do 20 mg/l. Slika 2 prikazuje diagram odvisnosti celokupne trdote glede na višino. V splošnem rastejo trdote z zniževanjem nadmorske višine.

Prevedla Maja Kranjc

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