DISCOVERY OF QUARTZ PEBBLES ON SUMMIT SURFACES IN THE ALTIPIANI AMPEZZANI (DOLOMITES, NE ITALY)

ODKRITJE KREMENOVIH PRODNIKOV NA OVRŠJU VISOKIH AMPEZZANSKIH PLANOT (DOLOMITI, SV ITALIJA)

Alfredo BINI,* Mirco MENEGHEL,** Yves QUINIF,***
Ugo SAURO** & Chiara SIORPAES****

Acta carsologica, XIX (1990), 197-206, Ljubljana 1990

Abstract UDC 551.44(234.323.33)

Alfredo Bini,Mirco Meneghel, Yves Quinif, Ugo Sauro & Chiara Siorpaes: Discovery of quartz pebbles on summit surfaces in the Altipiani Ampezzani (Dolomites, NE Italy)

During geomorphological field work on high altitude karst in the Dolomites near Cortina d'Ampezzo (Alpe di Fanes, Sennes e Fosses) quartz pebbles were found in many places, originating from formations now largely eroded from the tops of Dolomites or from karstic deposits. The occurrence of these pebbles is significant for the reconstruction of the evolutionary history of Dolomites.

Izvleček UDK 551.44(234.323.33)

Bini, Alfredo, Mirco Meneghel, Yves Quinif, Ugo Sauro & Chiara Siorpaes: Odkritje kremenovih prodnikov na ovršju Ampezzanskih visokih planot (Dolomiti, NE Italija)

Po 1984 letu so bili med geomorfološkim terenskim delom na visokih kraških planotah v Dolomitih blizu Cortine d'Ampezzo (Alpe Fanes, Sennes in Fosses) na več mestih najdeni kremenovi prodniki, ki izvirajo iz danes močno erodiranega materiala z vrhov Dolomitov ali iz kraških sedimentov. Pojav teh prodnikov je pomemben za rekonstrukcijo morfogenetskega razvoja Dolomitov.

* Dipartimento di Scienze della Terra, Università di Milano
** Dipartimento di Geografia, Università di Padova
***CERAK, Faculté Polytechnique de Mons
****Dipartimento di Geologia, Paleontologia e Geofisica, Università di Padova

The cost of this research has been provided by the Ministero dell'Università e della Ricerca Scientifica e Tecnologica.

During geomorphological field work on high altitude karst forms in the Dolomites near Cortina d'Ampezzo (Alpe di Fanes, Sennes e Fosses) in the period since 1984, quartz pebbles were found in many places, originating from formations now largely eroded from the tops of Dolomites or from karstic deposits (fig. 1). The occurrence of these pebbles is significant for the reconstruction of the evolutionary history of Dolomites.

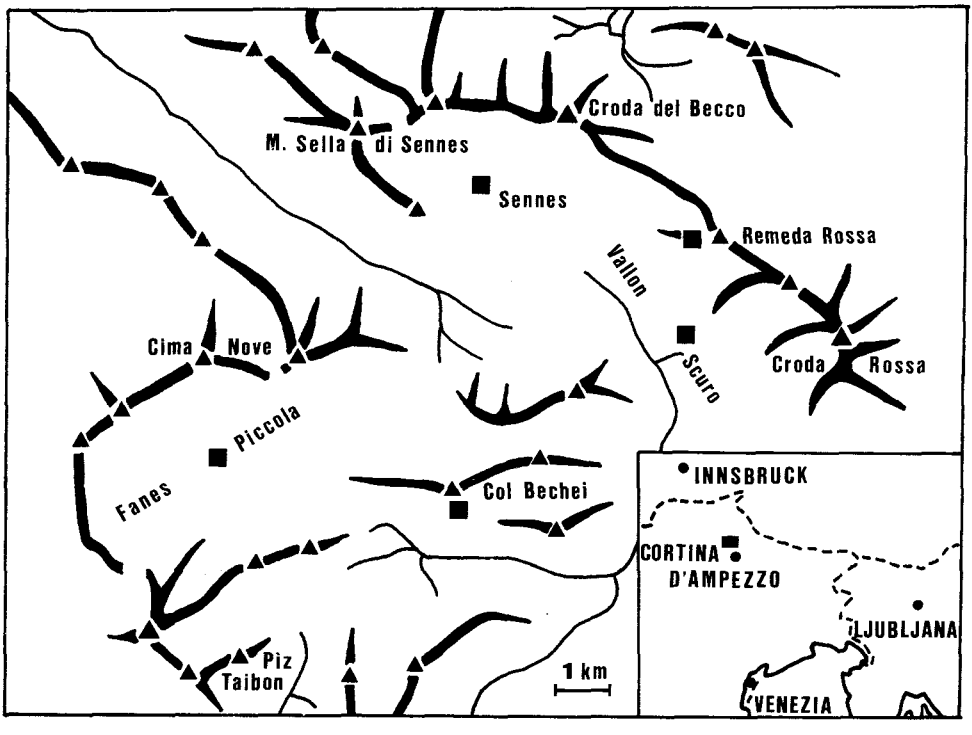

Fig. 1 Sketch map of the Altipiani Ampezzani. Black squares show the locations where the quartz pebbles were found.

Sl. 1 Skica Ampezzanske visoke planote. Črni kvadrati kažejo nahajališče kremenenovih prodnikov

GEOLOGICAL AND TECTONIC SETTING

The Altipiani Ampezzani area is located in the northeastern part of the Dolomites (eastern Southern Alps, northern Italy). This region is bounded by the Neogene Periadriatic Lineament to the North and by the Valsugana - Pieve di Cadore Thrust to the South. The stratigraphic sequence consists of a Permo-Mesozoic sedimentary cover unconfor-

mably overlying the Hercinian metamorphic basement.

During the Tertiary two compressional tectonic phases deformed the Dolomites: the W-WSW trending Dinaric phase (pre-Upper Oligocene) and the Neogene S-ESE tending Valsugana phase (Doglioni, 1987; Doglioni & Siorpaes, in press). The two different tectonic phases can be distinguished from their structural position and the age of the M. Parei Conglomerate (Upper Oligocene - Lower Miocene). In fact the M. Parei Conglomerate lies with an angular unconformity (from 10° to 90°) on the Jurassic limestones deformed by the W-WSW trending Dinaric phase while, during the S-ESE trending Valsugana phase, tectonic sheets of Mesozoic rocks were thrusted over this formation.

QUARTZ PEBBLE LOCATIONS

Pebbles were first discovered on the Remeda Rossa ridge, at an altitude of some 2450 m. Here the pebbles are scattered on the ground over a small area. The quartz pebbles, a few centimetres in diameter, occur in association with many small clasts of limonite. No deposit or formation from which the pebbles could have come was located.

Allochthonous deposits were also found on the left slope of the Vallon Scuro (a trunk of the valley of Boite Torrent), just south of point 2163 m. Here red sandstones rich in micas and with small pebbles of quartz fill a karstic pit, now dissected by slope erosion.

A few other quartz pebbles were found here and there scattered on the plateau of the Alpe di Sennes, between Sennes Lake, the Col delle Fezeres and the Mount Sella di Sennes. In the Alpe di Fanes Piccola, at an altitude of about 2325 m, only one other pebble has been found.

Quartz pebbles are present in the M. Parei Conglomerate, at an altitude of about 2570 m. This unit consists of mono- and polygenic conglomerates and greywackes outcropping on a morphostructural surface trending E-W, under the very top of Col Bechei. There is another outcrop at 2377 m a.s.l. between Col Bechei di Sotto and Croda d'Antruilles.

For a long time the M. Parei Conglomerate was considered Upper Cretaceous in age and was compared with the Gosau Formation of the Northern Calcareous Alps. M. B. Cita & G. Pasquarè (1959) ascribed this formation to Eocene and later P. Cros (1966, 1978) dated it to Upper Oligocene - Lower Miocene.

The conglomerate and the greywackes are arranged in fining-upward sequences and consist of well rounded pebbles of different lithology; in the carbonate matrix marine facies fossils, like Balanus sp., red algae, foraminifera (lepidocyclina and amphystegina) are also present. The unit was probably sedimented on a shore or in a shallow water sea and the clasts were deposited by different rivers (P. Cros, 1966, 1978).

The quartz pebbles are not the dominant pebble lithology in the conglomerate, but just at the foot of the slope made by the outcrop, were loose clasts collect, quartz pebbles are more abundant (M. Panizza & D. Dibona, 1990) and limonite clasts also occur.

In an attempt to correlate the pebbles on the basis of their physical characteristics, pebble morphometry was used to compare the Remeda Rossa and Col Bechei samples, where there were sufficient clasts for the analysis to be statistically significant. Artificial thermoluminescence was used in the analysis of samples from Remeda Rossa, Vallon Scuro and Col Bechei.

PEBBLE MORPHOMETRY

The samples consisted of 68 pebbles from Col Bechei and 101 pebbles from Remeda Rossa. On each clast the three principal axes were measured to determine form, sphericity and flatness (E.D. Sneed & R.L. Folk, 1958), and the radius of curvature of the sharpest corner was used to calculate the index of roundness (A. Cailleux & J. Tricart, 1963). The mean form of both samples is spherical-lamellar, with the Remeda Rossa sample being slightly more lamellar.

The form indices and the other mean values calculated are listed in Tab. 1

Tab. 1

	Col Bechei	Remeda Rossa
Form index (a-b)/(a-c)	498	531
c/a	594	526
Sphericity	763	719
Flatness index	155	171
Roundness index	454	442

As one can see the values are quite similar and since there is no significant difference between the two groups of pebbles, it is possible to consider a common origin for the two deposits. If we take into account both flatness and roundness indices and compare them with the large range of values given by A. Cailleux & J. Tricart (1965) for quartz pebbles collected in various environments, it can be seen that the roundness index is higher for these samples than those for other environments though the values appear to fit more with samples of fluvial origin than with marine beach samples.

ARTIFICIAL THERMOLUMINESCENCE

Thermoluminescence (TL) is the property of some non conductor crystals (e. g. quartz) to emit light when warmed. This fact is due to the presence in the crystal reticule of physical and chemical defects which act as traps for electrons at an energy level higher than the usual band hosting electrons. Energy to carry electrons into the traps is given usually by natural radioactivity. Electrons can return to their band only by the supply of more energy, for instance given as heat. Falling again to their band, electrons emit pho-

tons producing visible light when the crystal is warmed. This is the Natural Thermoluminescence (NTL). Because the TL is due to the reticular defects of crystals, quartz crystallized in the same time and conditions have the same TL properties, while crystals formed in different conditions have a different TL behaviour.

The amount of light emitted by a crystal which is warmed produces a glow curve with a certain number of peaks at temperature values typical for every mineral. In natural quartzes low temperature peaks are always absent because relative traps are easily emptied by a very low amount of energy. Moreover ultraviolet light from the sun can empty all the traps, annulling the TL.

To obtain a glow curve with all the peaks and without any interference it is necessary to measure the Artificial Thermoluminescence (ATL) of the quartz. To obtain it, the quartz crystals are exposed for a long time to ultraviolet light, then they receive sufficient energy by gamma or X rays so that all the available traps are filled. Afterward the quartz crystals are warmed giving a glow curve typical of the mineral and independent from the conditions met by the quartz crystals after their formation.

So if two samples of quartz sediment coming from different places have the same shape of ATL glow curves (also with little difference in the intensity of the peaks), they probably originate from the same geologic formation. In such a way it is possible to use the ATL as a sedimentological tracer, for instance to identify the different sources of sediments in a basin.

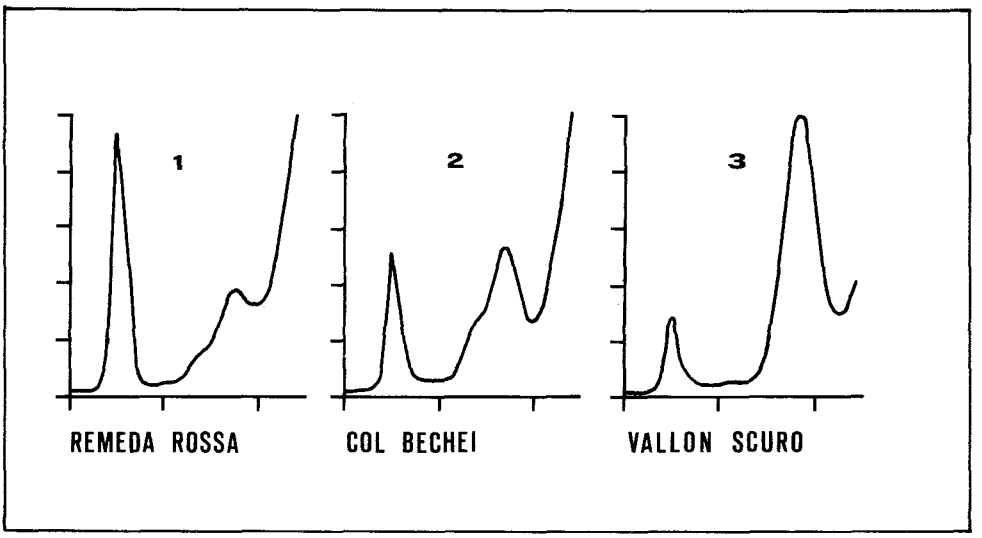

Fig. 2 Thermoluminescence glow curves (intensity of light against temperature) of the three samples.

Sl. 2 Termoluminiscenca žarilne krivulje (intenzivnost svetlobe glede na temperaturo) v treh vzorcih.

For our purposes we analysed quartz pebbles from Remeda Rossa (size 1 - 3 cm, sample 1), from Col Bechei (size 2 - 4 cm, sample 2), and from the sandstone of Vallon Scuro (size about 0.5 cm, sample 3). The portion larger than 200 micron was separated with a heavy liquid (bromoform with density 2.62) and treated for one hour in hydrofluoric acid at 50% to eliminate the surficial layer of the grains. The TL had been cancelled by exposure to an ultraviolet lamp for 24 hours. After that the quartz received radiation from a gamma beam source for one hour. the ATL was then measured while a plate warmed the sample at a rate of 2°C/sec. Several pebbles were analysed from each sample location.

The glow curves typical of the three samples are shown in Fig. 2, while temperature and intensity values of the peaks are listed in Tab. 2.

Tab. 2: Temperature and intensity of the peaks of quartz samples.

	1		2		3	
	Remeda Rossa		Col Bechei		Vallon Scuro	
	t °C	I	t °C	I	t °C	I
1st peak	96,2	5507	96,2	4397	96,2	4873
2nd peak	290,5	1039	274,7	2324	227,1	936
3rd peak	346,1	2197	334,2	4611	361,9	17489

The shape of the curves and temperature and intensity values show that the quartz of the Remeda Rossa and Col Bechei samples is identical, while the Vallon Scuro quartz is different. The curves of samples 1 and 2 show a first high peak, with a smaller second peak at higher temperature; on the contrary the first peak of the sample 3 is simple and has low intensity. The second peak is well developed in the curves of sample 1 and 2, while it is very low and at lower temperature in the sample 3 curve. The third peak has low intensity and partially overlaps the second peak in the 1st and 2nd samples, whilst it is high and well separated from the second peak in the 3rd sample.

Therefore the quartz pebbles of the Remeda Rossa and Col Bechei come from the same formation, while the quartz pebbles sampled from the karstified pit of Vallon Scuro have a different origin.

CONCLUSIONS

The problems of the geomorphologic history of Dolomites has interested researchers for a long time. One of the main questions is the meaning and the correlations between old surface remnants. Such problems are discussed in the works of A. Sestini (1955) and D. Rossi (1957) for the whole Dolomites and of L. Kober (1908), G. Merla (1931), C. Mutschlerchner (1937), E. Bevilacqua (1953), and P. Cros (1978) for that part considered in this paper.

One of the problems is the relation between the remnants of an old erosional surface present here and there at the top of some mountains and a more widespread surface situated some hundred metres below. For the area discussed in this paper the first surface is clearly visible at the tops of Sasso delle Nove, M. Sella di Sennes, Croda del Becco, Remeda Rossa and Piccola Croda Rossa. This surface could be related to *Gipfelflur* of the German authors and is generally considered of Miocenic age. The quartz pebbles found on the surface of the Remeda Rossa and the limonite clasts found here and on the Croda del Becco could be similar to the deposits of the *Augensteinlandschaft* (or *Raxlandschaft*) of the Northern Limestone Alps, probably also of early Miocene age (J.Fink, 1975).

The second surface, in this area is that of Fanes Piccola, Sennes and Fosses; it is widespread and has a rather large variation in altitude, but it is about 300 - 400 metres below the top surface. A question arises as to whether the two surfaces represent two different levels of erosion (and so the last surface could be of Pliocene age, A. Sestini, 1955) or a originally undulating surface afterwards also displaced tectonically.

If we consider the terrace of Col Bechei, where the conglomerate outcrops, as part of the lower surface, since the Remeda Rossa pebbles have the same origin as those in the conglomerate, we can deduce that the two surfaces of the Ampezzo Dolomites have the same origin and age, at least Aquitanian and perhaps Oligocenic. At that time the landscape could have been a limestone hilly plateau bounded by a sea, where rivers deposited materials coming also from metamorphic zones of the Central Alps as suggested by P. Cros (1978).

Of course this reconstruction could be rash, being based on only one reliable observation; the possibility of sedimentation of reworked materials, the different origin of the sandstone of Vallon Scuro and the presence of quartz pebbles at M. Faiburn (probably Piz Taibon) reported by P. Cros (1978), that could have a different origin, may complicate the framework in which we attempt to insert the morphological history of the Ampezzo Dolomites. Nevertheless we think that these observations will be important in disentangling the history.

REFERENCES

Bevilacqua, E., 1953: Aspetti morfologici della regione di Fanes. C.N.R., Centro Studi per la Geogr. Fisica, Ricerche sugli aspetti morfologici di territori italiani, 1, Faenza, 71 pp.

Cailleux, A., J. Tricart, 1963-1965: Initation a l'étude des sables et des galets. 3 vol, C.D.U., Paris, 369, 194 and 202 pp.

Cros, P., 1966: Age oligocène supérieur d'un poudingue du Monte Parei dans les Dolomites centrales italiennes. C.R. Géol. France, 7, 250-252.

Cros, P., 1978: Interpretation des relations entre sediments continentaux intrakarstiques et molasses littorales, oligo-miocene des Dolomites centrales italiennes. Atti Cong. "Processi paleocarsici e neocarsici", Napoli, 12 pp.

Doglioni, C., 1987: Tectonics of the Dolomites (Southern Alps - Northern Italy). J. Struct. Geol., 9, 181-193.

Doglioni, C., C. Siorpaes, 1990: Polyphase deformation in the Col Bechei area (Dolomites - Northern Italy). In press.

Fink, J., 1975: Changes of climate and land-forms in the Eastern Alps. An. Acd. Brasil. Ciênc., 47 Supl., 327-336.

Kober, L., 1908: Dachsteinkalkgebirge zwischen Rienz Gader und Bòita. Mitt. Geol. Ges., 203-244.

Merla, G., 1931: Osservazioni morfologiche e tettoniche sugli altipiani ampezzani (Fosses - Sennes - Fanes). Atti Soc. Toscana Sc. Nat., Mem., 42, 45 pp.

Mutschlerchner, C., 1937: Geologie der St. Vigiler Dolomiten. Jhrb. Geol. Bundesanst., 83 (1-2), 75 pp.

Panizza, M., D. Dibona, 1990: Segnalazione di un suolo al Col Bechei (Dolomiti di Fanes) e suo possibile significato neotettonico. Il Quaternario, 3 (1), 31-38.

Rossi, D., 1957: Gli aspetti morfologici delle cime Dolomitiche. Boll. Soc. Geol. It., 76, 46-66.

Sestini, A., 1955: Alcuni problemi di morfologia delle Dolomiti. Riv. Geogr. It., 62, 101-112.

Sneed, E.E., R.L. Folk, 1958: Pebbles in the lower Colorado River, Texas. A study in particle morphogenesis. Journ. Geol., 66, 114-150.

ODKRITJE KREMENOVIH PRODNIKOV NA OVRŠJU AMPEZZANSKIH VISOKIH PLANOT (DOLOMITI, NE ITALIJA)

Povzetek

Raziskovalce že dolgo zanimajo vprašanja geomorfološke zgodovina Dolomitov. Eno poglavitnih vprašanj je pomen in razmerje med ostanki starih uravnav. Ta vprašanja obravnavajo dela A.Sestinija (1955) in D.Rossija (1957) za celotne Dolomite in L.Koberja (1908), G.Merla (1931), C.Mutschlerchnerja (1937), E.Bevilacque (1953) in P. Crosa (1978) za področja, ki jih obravnavamo tudi v tem prispevku.

Eden od problemov je razmerje med ostanki stare erozijske uravnave na vrhu nekaterih gora in običajnih ravnot,ki jih najdemo nekaj sto metrov niže. Na obravnavanem območju, so prve reliefne oblike jasno vidne na vrhu Sasso delle Nove, M.Sella di Sennes, Croda del Becco, Remeda Rossa in Piccola Croda Rossa. Te uravnave lahko pripadajo tipu *Gipfelflur* (nemških avtorjev) in običajno jim pripisujemo miocensko starost. Kremenovi prodniki, ki smo jih našli na ovršju Remede Rosse in limonitni klasti, najdeni tam in na Croda del Becco, bi lahko bili podobni sedimentom *Augensteinlandschaft* (ali *Raxlandschaft*) v Severnih Apneniških Alpah, ki so tam verjetno miocenske starosti (J. Fink, 1975).

Drugi tip uravnav na tem območju so Fanes Piccola, Sennes in Fosses; to je prostrano površje s precejšnjimi višinskimi razlikami, ležeče okrog 300-400 m niže od vrhov. Pojavlja se vprašanje, ali ti dve uravnavi predstavljata dve različni erozijski fazi (tako bi bila lahko zadnja uravnava pliocenske starosti, A.Sestini, 1955), ali izvorno razgibano površje, ki je bilo tektonsko premaknjeno.

Če smatramo teraso Col Bechei, kjer izdanjajo konglomerati, kot del nižjega površja in so prodniki z Remeda Rossa enakega izvora kot konglomerati, lahko sklepamo, da sta ti dve uravnavi na Ampezzanskih Dolomitih istega izvora in starosti, vsaj akvitanijske ali mogoče oligocenske. V tem času bi bila pokrajina apneniška gričevnata planota, omejena z morjem, kjer so reke odlagale tudi material, prihajajoč z metamorfnih področij Centralnih Alp, kot to predpostavlja P. Cros (1978).

Seveda je taka rekonstrukcija groba, ker je osnovana le na enem zanesljivem opazovanju; možnost sedimentacije predelanega materiala, različen izvor peščenjaka iz Vallon Scuro in prisotnost kremenovih prodnikov na M. Faiburn (verjetno Piz Taibon), o katerih poroča P.Cros (1978), ki imajo morda drugačen izvor, lahko zapletejo osnovno tezo, s katero poskušamo razložiti morfološko zgodovino Ampezzanskih Dolomitov. Kljub temu mislimo, da so ta opazovanja pomembna za razvozljavanje njihove zgodovine.

Prevedla Maja Kranjc

O kremenovem produ so razpravljali na italijansko jugoslovanski konferenci o alpskem krasu julija 1989 v Dolomitih. Konference so se udeležili iz Jugoslavije I. Gams, P. Habič, J. Kunaver, A. Mihevc, S Šebela in N. Zupan. Kremenov prod je ohranjen tudi v Julijskih in Kamniških Alpah ter po Dinarskem krasu.

Urednik