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GEOCHEMISTRY OF THE PIETRAROJA CRETACEOUS PLATTENKALK (S-ITALY), AND COMPARISON WITH THE BOLCA EOCENIC PLATTENKALK (N-ITALY).

PIETRAROJA: GEOLOGICAL SETTING

The Pietraroja fossil-lagerstätte, now worldwide famous for the finding of the first Italian dinosaur in the Apennine chain, the *Scipionyx samniticus* (Leonardi & Teruzzi, 1993; Dal Sasso & Signore, 1998) is a site known for its fossils from the first quarter of the last century (Breislak, 1798).

Important and recent contributions to its geological knowledge are in D'Argenio (1963); Bravi & Garassino (1998); Freels (1975); Catenacci & Manfredini (1963). At the "Civita di Pietraroja" (Benevento province, I.G.M. Sheet 162 III SW - Cusano Mutri), two plattenkalk horizons crop out in the mesozoic carbonate platform sequence. These horizons have been recently updated to the lower Albian (Bravi & Garassino, 1998) mainly by the presence of the foraminiferid *Ovalveolina reicheli* DE CASTRO. The lower plattenkalk is about 6 metres thick along the vertical slope previously sampled by one of us. Its facies is of marine-lagoonal, strongly protected environment, but fossils are rare. Above the first plattenkalk horizon, a 20 metres thick sequence of restricted lagoonal limestones is present. This part of the stratigraphical log is very rich in orbitolinids, among which *Paracoskinolina tunesiana* PEYBERNES and *Cribellopsis* cf. *arnaudae* CHIOCCHINI, which confirm the lower Albian age assigned to the outcrop. On these microfossiliferous strata the upper plattenkalk lies : this is the most famous fossiliferous level from which the *Scipionyx samniticus* comes from. The plattenkalk thickness is about 8-9 metres on the NE slope of the "Civita", but its thickness seems to increase moving to SW, in the direction of "le Cavere" outcrop (the classical site), where it reachs about 15 metres. The sedimentological and paleoenvironmental data seem to indicate that this upper plattenkalk horizon formed in a shallow carbonate platform depression, often isolated from the open sea, filled by microturbidite events due to the tides (Bravi & Garassino, 1998), and subject to storms. Different facies are present in the plattenkalk : "more marine horizons", constituted by finely graded limestone strata, 1 cm up to some tens of centimetres thick, and "more terrestrial horizons", constituted by sets of millimetric laminae of marly limestone, sometimes richer in land-plants remains, bituminous and rich in fossil fishes. These sets of laminae could witness the starvation periods of the lagoon, when the land influence was more marked. The chert is present in the plattenkalk, and is represented mainly by nodules in the proximal areas, but by continuing layers in the distal areas, closer to the centre of the basin.

About 2 km NE of the "Civita di Pietraroja", in the Mutria mount, a bauxite horizon crops

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out. The limestones constituting the Pietraroja's plattenkalks and the bauxite horizon substrate have the same facies and the same age, so it is possible to identify the Monte Mutria bauxite horizon as the lands which were present in the lower Albian, close to the Pietraroja lagoon.

Bolca : Geological setting.

The eocenic fossil site of Bolca, in the province of Verona, is worldwide known for its richness in fossils and their perfect state of preservation. Tens of thousands of specimens have been collected since 1555, and they are present in the natural history collections of all the museums in the world.

The fish fauna is constituted by over 150 species; plants are represented by about 250 species, and worms, crustaceans, insects, jelly-fishes, bivalves, cephalopods, reptiles and bird feathers are present, too.

The two best known outcrops are "La Pesciara" of Bolca and Monte Postale. La Pesciara looks like a carbonate reef rock surrounded by volcanic materials and is constituted by a set of strata which are in the complex about 19 metres thick, strongly dipping to SE.

The age assigned by Medizza (1975) to the outcrop on base of the calcareous nannoplancton is the top of the lower Eocene or the base of middle Eocene.

Fishes and plants are present in 5 levels, separated by horizons containing only molluscs (Sorbini, 1967; Sorbini, 1980).

By a sedimentological point of view, the mollusc-rich horizons are constituted by coarse grained detritic limestone, sometimes including clasts of more than 50 cm of diameter, containing alveolinids, corals and calcareous algae. They were carried in place during high energy events, with mass transport phenomena. Instead, the fossil fish and plant bearing horizons show a varved structure, and are constituted by regular laminae sets with a finely-graded structure. At the base of the laminae, small foraminifers, ostracods and broken mollusc remains are present, gradually passing up to very fine mudstone to the top. Very fine and dispersed pyrite granules and carbonaceous organic remains are present in the laminated horizons.

The alternance of finely laminated layers and mollusc-rich coarse-grained massive strata seems to outline a depositional environment which was subject to alternate phases of isolation from the open sea and very low sedimentary energy, and storm events with mass-transport of sediments from reef areas which were not far from the lagoon.

GEOCHEMISTRY

Both occurrences show two common features : they are very pure, and they exhibit silica layers. These layers are in Pietraroja clearly visible and frequent, but in Bolca not so well developed and soft. This leads to the main difference between the two "Fossil-Lagerstätten" : Pietraroja obviously has underwent a normal diagenesis and shows quite normal, sometimes lithographic limestones, whereas Bolca consists of a sequence of soft, sometimes chalky beds. A clear distinction between limestones and marls is in Bolca impossible. Diagenesis has not yet come to a normal end, although Bolca is situated in the Alpine region, and volcanism has happened nearby. This may be due to the difference in age.

Pietraroja is a very pure plattenkalk, and in this respect only comparable with Cerin and

Canjuers (France). Bolca, however, is distinctly purer than that group. Tab. 1 may illustrate this :

	PIETRAROJA				BOLCA	
	lmst.	marls	maxim.		lmst.	maxim.
SiO2	0,5	3,2	(silific.)	SiO2	0,1	0,45
Al2O3	0,2	1,0	2,4	Al2O3	0,03	0,08
Fe2O3	0,1	0,4	1,3	Fe2O3	0,05	0,08
K2O	0,05	0,2	0,5	K2O	0,007	0,018
MgO	0,55	0,65	0,8	MgO	0,6	0,7
P2O5	0,03	0,04	0,09			
Sr	400	500	550	Sr	600	950

Table 1 : Abbreviated survey about the average contents of the more important elements

The limestones of Pietraroja exhibit an average content of noncarbonate residues of around 0,9, whereas the beds of Bolca show less than 0,2. Therefore Bolca is one of the purest limestones at all.

In Pietraroja the usual good correlations between the clastic elements are developed. In Bolca, however, all the points plot so closely near the zero point that never a good correlation is visible. This is unique among the plattenkalks.

Interesting is the behaviour of the element Sr. In first approximation the Sr values in limestones are proportional to the insoluble residues (this is a paradox, not discussed here in detail; compare Bausch, 1968). Seen on this background, the Sr values of Pietraroja are rather high. This may be due to a high primary percentage of aragonite, or to higher salinity, during sedimentation. - In Bolca, however, the Sr values are even higher than in Pietraroja, although the beds are purer. Besides the reasons mentioned above, the not finalized diagenesis of Bolca may be the reason.

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