Bituminous intercalations in the Cretaceous of the Breggia river, s. Switzerland

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Bituminous Intercalations in the Cretaceous of the Breggia River, S. Switzerland

by P. BITTERLI[1])

Introduction

In July 1957 the bituminous shale intercalations in the Cretaceous Scaglia and Maiolica of the Breggia river, 2 km NW of Chiasso, S. Switzerland, were surveyed in order to obtain information and sample material for an extended research project on primary bituminous rocks of Western Europe (BITTERLI 1962, 1963).

Field work was carried out by Messrs. F. WIEDENMAYER and A. BRANTS, under the supervision of the author. In the laboratory the rocks and thin sections were examined sediment-petrographically by O. VAN WEST and later again by A. FEHR, while the geochemical analyses were directed by E. EISMA and J. A. GRANSCH.

In view of the renewed interest in the Scaglia section as a reference profile and the recent construction of a cement factory which obliterated much of the original exposure conditions, the writer welcomes this opportunity to publish the present brief note. Although it has to be considered as a contribution to H. LUTERBACHER's paper rather than as a self-contained publication, it was found desirable for a number of technical reasons to publish it as a separate article. As analytical data of rock samples originating from bituminous sequences are not frequently found in the literature, the writer feels particularly indebted to Bataafse Internationale Petroleum Maatschappij N.V., The Hague, and to the Royal Dutch/Shell Exploration and Production Laboratory, Rijswijk, for their permission to publish this information.

Geological Remarks

The occurrence of bituminous fish shales in the Scaglia was described by VONDERSCHMITT (1940), GANDOLFI (1942), and others. It was also previously known that dark, possibly bituminous shales are intercalated in the limestone banks of the upper Maiolica (Biancone) and that some beds of the lower Flysch emit a fetid smell when freshly broken. It was therefore decided to collect selectively samples from these formations for laboratory analysis. No samples were taken from the Scaglia rossa or from other obviously non-bituminous beds.

For the location and the stratigraphic position of the samples investigated reference is made to Figs. 1 and 2.

1) BIPM, The Hague.

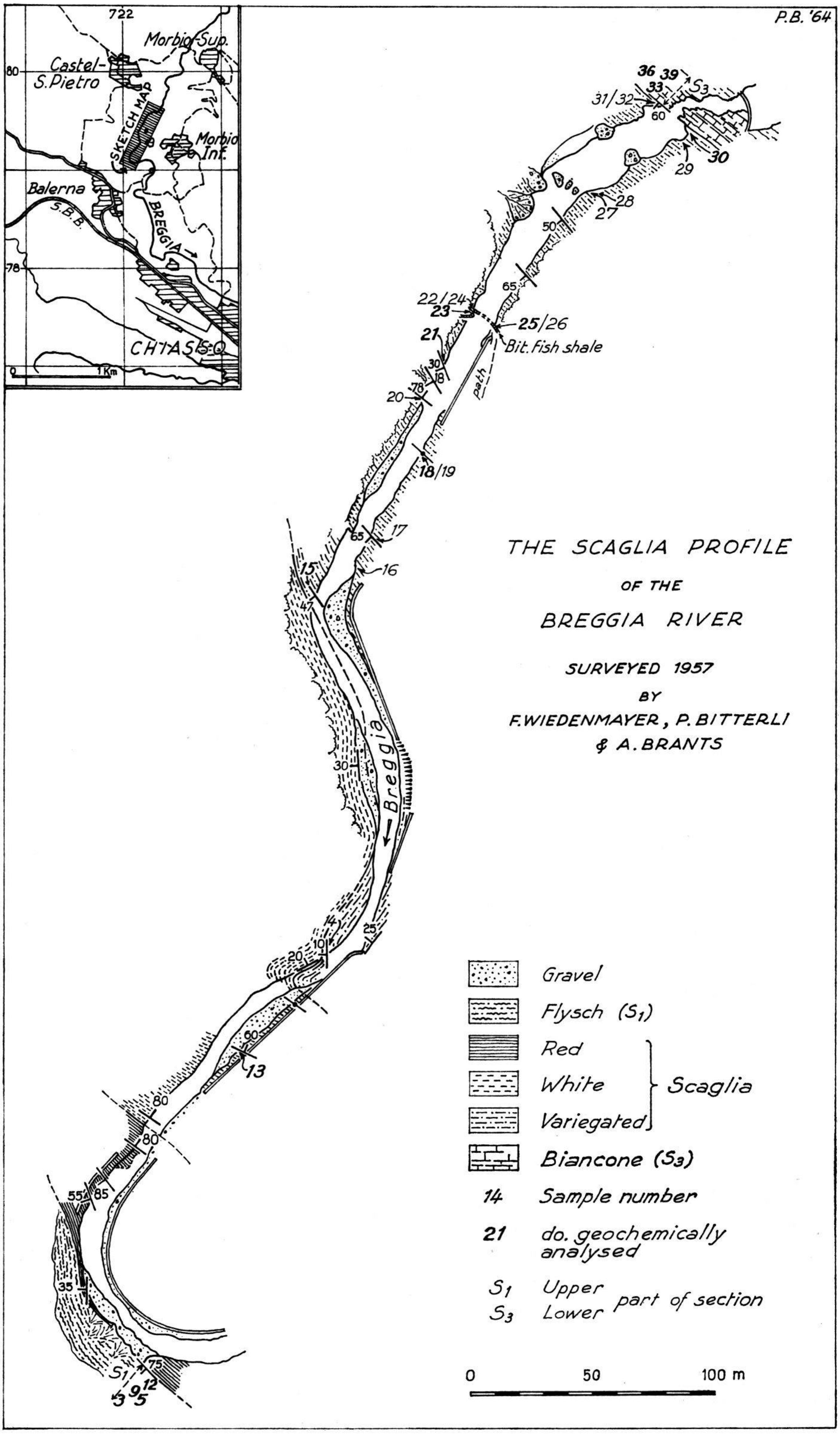

Fig. 1: The Scaglia Profile of the Breggia River, surveyed 1957 by F. WIEDENMAYER, P. BITTERLI & A. BRANTS.

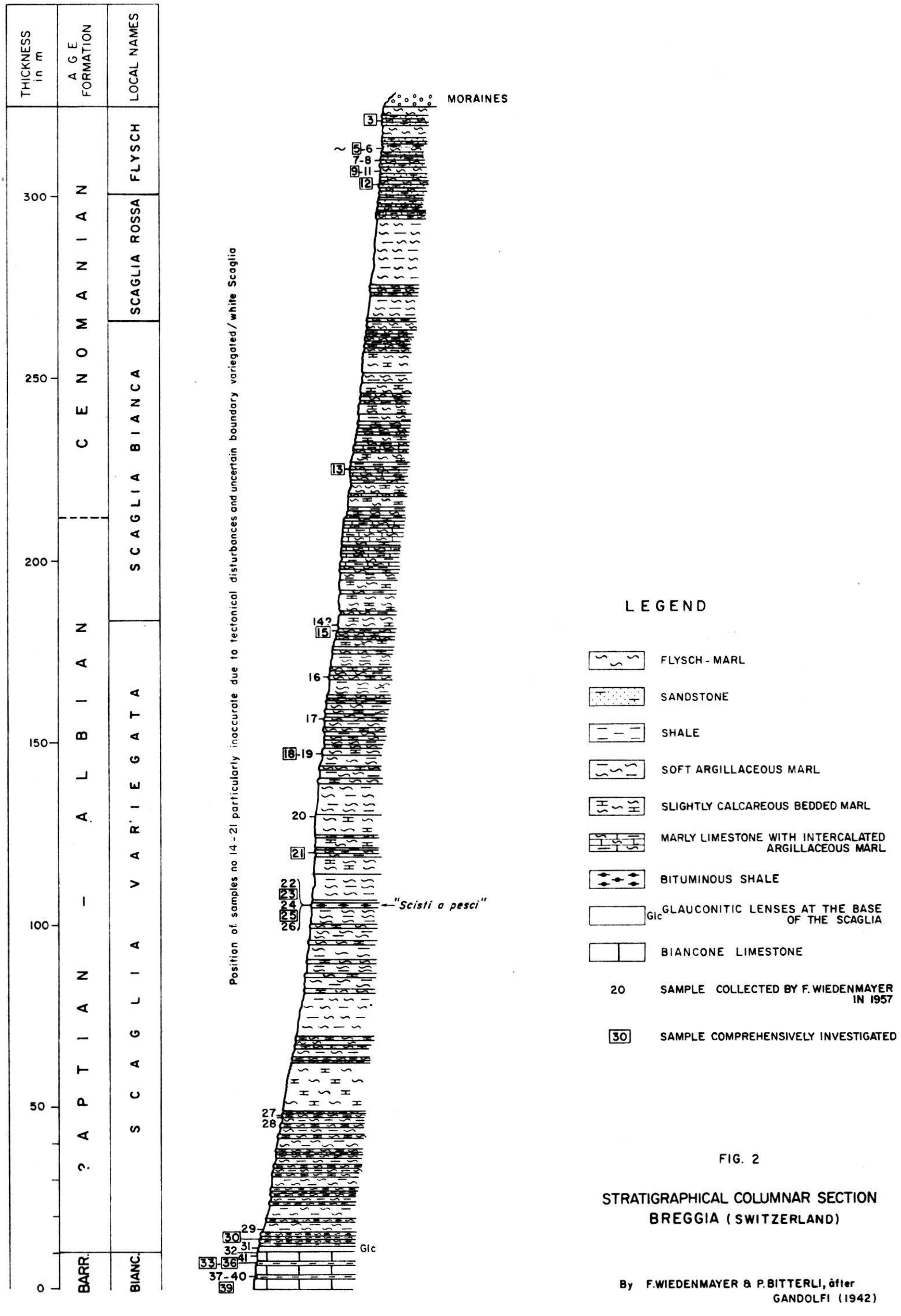

Fig. 2: Stratigraphical columnar section, Breggia (Switzerland), by F. WIEDENMAYER & P. BITTERLI, after R. GANDOLFI (1942).

Petrography

a) Maiolica (Biancone); samples Wie 41–32.
The lowermost 10 m of the section surveyed consists of pale grey, microcrystalline limestone with intercalated thin layers of dark grey, weakly bituminous to coaly, calcareous shales with pyrite and fish remains (mainly scales).
The limestone has a homogeneous texture and is composed of very fine-grained calcite; at least some of these grains appear to be organisms, probably *Nannoconus*. A description of this Biancone profile and its nannoplankton is given by Grunau (1956).
The shale sample Wie 33 contains, besides calcite, chiefly clay revealing lenticular lamination and brown to opaque pyritic and bituminous matter including reddish-brown phosphatic fragments interpreted as fish remains.

b) Scaglia; samples Wie 31–13.
The middle part of the section comprises about 300 m of the Scaglia (variegata, bianca, rossa), composed of varicoloured clays, marls and subordinate limestones, with one principal layer of bituminous siliceous shale containing abundant fish remains, and additional minor bituminous intercalations.
Above the Maiolica about 10–20 cm of greenish, soft, glauconitic marl (Wie 31) indicates not only a sharp break in the charakter of sedimentation but possibly also a hiatus. Besides coarse (200 μ — 1 mm) green glauconite pellets, the thin section shows pale to brown phosphatic fragments and quartz grains.
The overlying Scaglia exhibits a strongly varying clay/marl/calcareous shale/argillaceous limestone sequence, represented by samples Wie 30, 18, 15, 13 in order of increasing carbonate content.
Of particular interest are the bituminous intercalations in the lower Scaglia. At about 100 m above the Maiolica a 0.5 m-thick bed of dark, bituminous, laminated «fish shales» occurs, two samples of which (Wie 25 & 26) were found to be composed of peculiar siliceous lenticles, of brownish bituminous material, OH-apatite (fish fragments?), coaly powdery matter and an argillaceous matrix. A coloured microphotograph of a thin section of sample Wie 25 was published by the author (Bitterli, 1963b). The siliceous lenticles consist of a fine mosaic of quartz and occur in discontinuous small lenses oriented parallel to the bedding planes; they are possibly not of detrital origin but either formed by micro-organisms, by transformation of clay minerals or by some other contemporaneous or early post-depositional process.
About 15 m above the «fish shales» another, though less bituminous, layer (Wie 21) occurs. The sample investigated consists of a clayey matrix with amorphous, brown bituminous films, some pyrite, phosphatic fragments and a little silty quartz.
From the overlying Scaglia, three samples (Wie 18, 15, 13) show an increasing lime content but only very little bituminous material and some phosphatic or coaly fragments. The calcareous samples show a varying content of clay minerals and microcrystalline calcite, with commonly finely silty material consisting of quartz and calcite, or showing thin streaks of opaque particles, and with sporadically minute phosphatic and glauconite pellets. Calcareous foraminifera *(Globotruncana)* are often present in great numbers.

c) Flysch
From the base of the Flysch 12 samples were collected covering about 18 m of an alternating sequence of marl, limestone and sandstone layers. The majority of the samples are limestones, more or less argillaceous, grey to dark grey in colour, and

Results of chemical analysis of samples from the Breggia river, S. Switzerland

Sample No. WIE	% gasoline extract on dry sample	% ether extract (gasoline-extracted sample)	% total nitrogen on dry extracted sample	% organic carbon on dry extracted sample	% soluble in boiling 5 % HCl	% non carbonate ash [1]	% Ca [2]	% Mg [3]	% Mn [4]	p.p.m. V [3]	p.p.m. Ni [3]	porphyrins: relative intensity absorption maximum at 550 mμ [5]	porphyrins: relative intensity absorption maximum at 570 mμ [5]
3	0.002	0.014	0.038	0.7	61	36	20	1.9	1	130	90	+++	—
5	0.007	0.023	0.057	1.1	75	22	30	0.9	1	220	100	++++	—
9	0.005	0.020	0.042	0.9	78	19	30	1.0	1	110	100	++++	—
12	0.005	0.016	0.039	0.8	69	27	20	1.5	1	130	160	++++	—
13	0.002	0.008	0.021	0.4	63	33	20	1.0	1	50	70	±	—
15	0.002	0.006	0.021	0.4	57	39	20	1.6	1	80	100	—	—
18	0.003	0.008	0.046	0.7	33	60	10	1.0	1	110	140	±	—
21	0.017	0.076	0.221	4.3	34	53	10	1.0	1	140	390	++++	—
23	0.158	0.278	0.188	6.8	32	53	10	0.7	1	410	440	++++	+
25	0.569	0.586	0.353	13.6	20	58	5	0.5	1	210	430	++++	—
30	0.003	0.010	0.056	1.0	11	82	2	1.6	0.3	230	220	—	—
33	0.014	0.062	0.184	3.3	36	52	10	1.5	0.3	150	310	++++	—
36	0.007	0.030	0.081	1.4	74	21	30	0.6	0.8	50	140	n. d.	n. d.
39	0.001	0.008	0.011	0.2	76	22	30	0.6	0.8	40	40	±	—

1) Combustion residue of HCl-insoluble residue
2) Accuracy about 40 %
3) Accuracy about 20 %
4) Estimate based on intensity of emission lines
5) Estimated with hand spectroscope; the maximum at 550 mμ is attributed to porphyrin nickel complexes, that at 570 mμ to porphyrin vanadium complexes

n. d. not determined — not observed
\+ trace +, ++ etc. increasing concentrations

with characteristically small forams (diameter about 100 μ), often filled with pyrite. Organic matter, decreasing towards the top of the section, consists mostly of coaly fragments, rare bituminous streaks and fish remains.

Geochemistry

The geochemical results of 14 samples analysed are listed in the accompanying tabulation.

From the Maiolica section, three of the dark shale intercalations (WIE 39, 36 & 33) were examined; from the Scaglia seven samples include the «fish shales» (WIE 25, 23) and other horizons (WIE 30, 21, 18, 15 & 13) of the variegated and white Scaglia, while four samples (WIE 12, 9, 5 & 3) originate from the Flysch.

The geochemical results show the two samples of the «fish shales» to be particularly bituminous, with WIE 23 containing over 8% organic material (6.8% org. C) and WIE 25 even more than 17% (13.6% org. C). The corresponding extracts (total of gasoline and ether extract) amount to 0.436% and as much as 1.155%, respectively, resulting in fairly high «solubility ratios» (total extracts: org. C multiplied by 10^3) in spite of the relatively high contents of organic carbon. This may indicate that some soluble hydrocarbons are present besides the usual kerogen, which is substantially insoluble in the organic solvents used. Also the C:N ratios of these two samples are much higher than those of the others.

Sample WIE 21, though containing about two-thirds (=4.3%) as much org. C as WIE 23, shows much less «solubility». This may indicate the presence of more insoluble kerogen material, including coaly matter.

The very same «solubility ratio» is calculated for sample WIE 33 from the dark shale intercalations in the Maiolica. Although the organic carbon content is somewhat less (3.3%), the total extracts are also correspondingly smaller.

The remaining samples contain less than 1.5% org. C, but still small amounts of extracts. This, together with the presence of porphyrins even in the strongly calcareous Flysch samples, may point to the deposition of organic material under slightly reducing conditions.

Concluding Remarks

From a comprehensive investigation of a number of samples from the Cretaceous of the Breggia section it is inferred that deposition took place in an open-marine, quiet environment. It is still somewhat controversial, however, whether the top of the Maiolica (Biancone limestone), marking a sharp lithological break, does indeed at the same time indicate a change from somewhat shallower to deeper water or vice versa, although both environments were probably open marine (pelagic).

The presence of primary bituminous matter in substantial to small amounts at various horizons indicates that a combination of factors, such as stagnant water and oxygen deficiency, may have caused repeatedly reducing conditions which, together with an appreciable influx of organic material, then occasionally provided the necessary conditions long enough for the preservation and accumulation of the dead organisms, such as found in the «fish shales».

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