KUKAL 1986, and SUCHÝ et al. 1996). According to PETRÁNEK (1951b) the crinoid stems were the source of the Mg, which is supported by the common crystallization centres in their axial canals observed in coarse-grained crinoidal limestones (Cikánka, Velká Chuchle, Požáry). The original crinoid skeleton was composed of low-Mg calcite (PETR et al. 1997). NÁPRSTEK's theory (1954) of stagnant water with a high concentration of Mg-ions is highly improbable. Micritic to biomicritic limestones of deeper-water origin contain mainly early diagenetic dolomite. The source of Mg-ions could thus have been the sea water, the micritic matrix, and/or organic matter.

Several types of silicification have been observed, although it occurs infrequently. One type is represented by microscopic nodules of chalcedonic quartz (Velká Chuchle, Kosov, Požáry) as described by SVOBODA et al. (1957). These nodules probably originated by the local replacement of sparite or micrite by radial fibres of chalcedony (pl. 7 – fig. 3). Fracture fills can also serve as centers of silicification.

Another type of silicification is represented by silicified bioclasts in coarse-grained bioclastic limestones (Cikánka, Kosov; pl. 7 – figs. 1 and 2). Crystals of early diagenetic dolomite invading silicified crinoid stems show that silicification preceded dolomitization. This is in agreement with PETRÁNEK (1951b), NÁPRSTEK (1954), and KUKAL (1955b), all of whom considered silicification in the Barrandian limestones to have been of an early diagenetic origin. Quartz fillings of fractures in the biomicritic limestone of the Požáry quarry (Lower Přídolí) show that late diagenetic silicification also occurred. The fractures are filled by first generation calcite and by second generation chalcedonic quartz.

A third type of silicification resulted in the nodular cherts that occur in the fine-grained Kosoř Limestone in the Radotín section (pl. 7 – fig. 4), in which sponge spicules are frequently preserved. The presence of idiomorphic dolomite crystals in the siliceous substance demonstrates that this silicification preceded dolomitization.

According to PETRÁNEK (1951b), PETRÁNEK and ŠTENGLOVÁ (1953), and KUKAL (1964) the sources of the silica were siliceous shells and sponge spicules. Other siliceous organisms reported from some Barrandian limestones, such as radiolarians by PETRÁNEK (1951a, b, c), were not found.

8. Geochemistry

Although the study of the chemical composition of carbonates in selected sections is not the main objective of this paper, we can compare some of our results with previously published data (such as SVOBODA et al. 1957, KUKAL 1964, PETR et al. 1997). Only rough data based on a limited number of analyses are presented here, for which FeO, MgO, and insoluble residues were analyzed in the main types of carbonates.

All the three plots show the positive correlation of the three components: FeO, MgO, and insoluble residue. This trend is especially pronounced in the micritic and biomicritic limestones.

By contrast, such correlations are not evident in shallow-water bioclastic (crinoidal) limestones. This can be explained by the observation that bioclastic limestones lack the micrite which contains clay and minute quartz grains.

The oxidation of Fe ions into Fe_2O_3 in a basinal dysoxic and/or anoxic environment is less probable than in well oxygenated, shallow-water zones (such as the Cikánka or Lower Lochkovian in the Požáry quarry). The shallow marine facies of the Lower Devonian (e. g. the Kotýs, Slivenec, and Řeporyje Limestones) are often red or pink-coloured due to the presence of Fe-pigment. It is well known that Fe ions are often fixed in a bivalent form in dolomite, and sometimes in clay.

Most of the MgO is bound to dolomite, and only small amount to clay minerals. In micritic limestones the early diagenetic dolomite predominates, but in bioclastic lime-

Table 10. Results of chemical analyses

	layer	FeO [%]	MgO [%]	insoluble residue [%]	type of limestone
Lochkovian – Pragian	Čr-87	0.58	0.99	19.52	micritic or biomicritic
	Čr-70	0.46	0.99	8.7	micritic or biomicritic
	VCh-2	0.11	0.65	3.36	biosparitic
	VCh-22	0.24	0.82	4.52	micritic or biomicritic
	Cik-4	0.19	0.69	1.06	biosparitic
	Cik-16	0.11	1.5	2	biosparitic
Přídolí – Lochkovian	R-3	0.34	1	13.3	micritic or biomicritic
	R-12	0.13	0.8	11.18	biosparitic
	Po-161	0.24	1.92	1.7	biosparitic
Ludlow – Přídolí	K-3	0.1	0.41	2.02	biosparitic
	Ml-3	0.11	0.68	2.12	biosparitic
	Ml-8	0.21	0.75	7.98	micritic or biomicritic
	Po-96	0.03	2.52	4.82	micritic or biomicritic
	Po-98	0.06	0.74	2.46	biosparitic

Čr – Černá rokle near Kosoř, VCh – Homolka near Velká Chuchle, Cik – Cikánka near Praha-Slivenec, R – Praha-Radotín, Po – Požáry quarry near Praha-Řeporyje, K – Kosov quarry near Beroun, Ml – Marble quarry near Praha-Lochkov. Analysed in the chemical laboratories of the Czech Geological Survey by H. Hanušová, J. Šikl and M. Mikšovský.

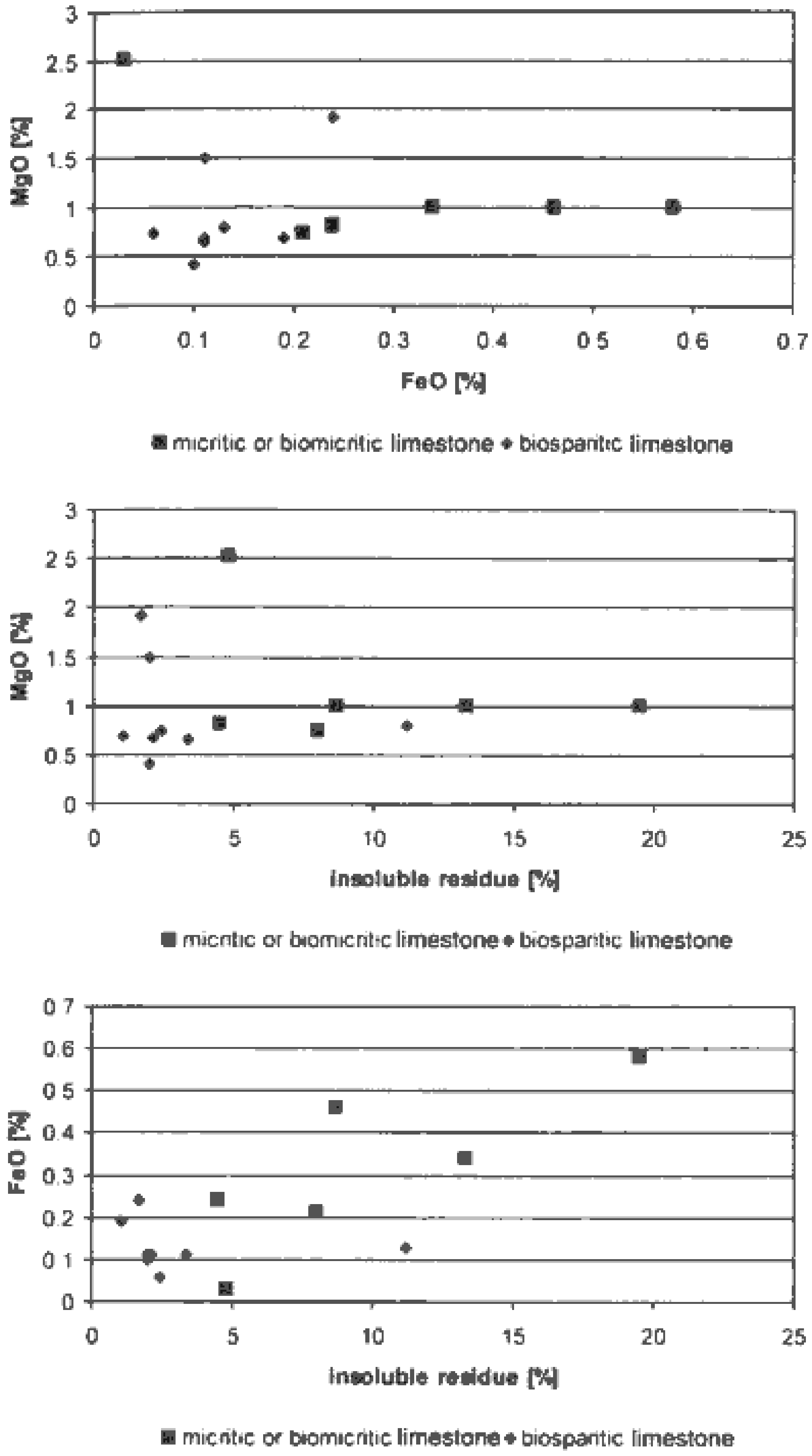

Figure 24. Graphs showing a correlation between FeO, MgO and insoluble residue.

stones both MgO and FeO are bound in the late diagenetic dolomite.

As expected, a positive correlation between MgO and FeO was found. This has been frequently observed in carbonates, and especially in the Barrandian sediments by SVOBODA et al. (1957) and KUKAL (1964). Their conclusions are based on thousands of analyses. Only several samples show a higher percentage of MgO without an elevated FeO content. This may be explained by the crystallization of dolomite with only reduced Fe in its crystal lattice.

9. Discussion

The utility of microfacies analysis

WILSON'S (1975) and FLÜGEL'S (1982) conception of standard microfacies (SMF) and facies belts (FB) is based on the study of Mesozoic and Cenozoic carbonates. However, the paleontological and sedimentological features of Early Paleozoic limestones differ from those of the Mesozoic. Thus, the relevance of using this method in the reconstruction of Paleozoic sedimentary environments is somewhat reduced. In spite of this, the microfacies analysis of Early Paleozoic carbonates can still be informative, if some variations are applied. This was shown by the study of VELEBILOVÁ and ŠARF (1996), who defined eight new microfacies partly comparable with SMF.

Wilson's microfacies analysis is fully applicable in relatively deep-water and transitional environments, where microfacies types correspond well to the SMF. However, the application is more ambiguous in shallow-water deposits where depositional mechanics were influenced by the presence of large crinoid biostromes. Such ecosystems are distinctly different from the Mesozoic reefs described by WILSON (1975) and FLÜGEL (1982). Crinoid forests excluded the development of most other organisms except some brachiopods and small trilobites. The morphology of such environments is not comparable to those of reefs or carbonate platforms. According to HLADIL (1994), the crinoid biostromes can be considered as elevations on flat continental shelves, often in an otherwise open marine environment.

Sections of micritic to biomicritic limestones with dark calcareous shales that correspond to SMF 9 or 3 often contain laminae or thicker layers of bioclastic limestones (SMF 5). This alternation cannot be explained by abrupt shallowing of the sedimentary basin and the onset of conditions favourable to the deposition of SMF 5, but by the redeposition of bioclastic material from shallow parts of the basin. A possible mechanism for this redeposition has been discussed above (see chapters 4–6).

10. General conclusions

The development of the Ludlow-Přídolí boundary beds differs among the localities considered in this paper. The Kosov section represents the shallowest developmemt of the Upper Ludlow. The deposition of crinoidal limestones took place at a depth of a few metres, in an area of large crinoid biostromes. These crinoid forests produced great amount of organic detritus which formed taluses at their margins. Such development is observed in the Marble quarry, where the depth has been estimated at a few tens of metres, yet still above the wave base. A specific situation is documented in the Požáry quarry where the influence of local current conditions between the Svatý Jan and Nová Ves volcanic elevations is presumed.

The development of the Lower Přídolí is rather uniform – micritic to biomicritic limestones interbedded with calcareous shales. This deposition took place at a depth of several tens of metres, below the wave base. The episodic input of coarser, detrital material from the shallower parts of sedimentary basin seems to have occurred.

A shallowing trend during the youngest Přídolí and the oldest Lochkovian time interval is evident from the NE part of the Prague Basin towards the NW. The drop in sea level caused the increased input of coarse, detrital, mostly crinoidal, material to the deeper part of the sedimentary basin, and the deposition of coarse-grained, bioclastic, crinoidal limestones. Debris flows could provide a mechanism by which the deeper basin was supplied with coarser detritus.

The Požáry quarry section, which corresponds to the shallow-water development of the Lochkov Formation (Kotýs Limestone), was close to a source of bioclastic material. This deposition took place in an environment above the wave base, at a depth of a few metres. The Podolí section belongs to the transitional development of the Silurian-Devonian boundary beds. The Radotín section corresponds to the deeper-water Radotín Limestone facies up to the transitional Kosoř Limestone facies. These sections were situated further basinwards, where the input of detrital material was more limited and periodically affected by stronger traction currents.

Microfacies analyses suggest that the deepest-water development of the Lochkovian-Pragian boundary beds occurred at Černá rokle near Kosoř. The depth is estimated to have been a few hundreds of metres, which corresponds to the deeper part of a continental shelf. After the regressive event of the Lochkovian-Pragian boundary, a gradual deepening of the sedimentary basin is evident, connected with a facies shift within the boundary strata of the Lochkov and Praha formations. The presence of a typical shallow-water SMF in the deeper part of the basin may be explained as the redeposition of coarse-grained bioclastic material from shallower regions by turbidite currents.

A transitional facies development is located in the stratotype section at Homolka near Velká Chuchle. The deposition of these beds took place at a maximum depth of a hundred metres, which corresponds to a shelf environment close to sources of organic detritus. A shift in facies belts in the wider boundary interval is also demonstrable.

Cikánka, near Praha-Slivenec, corresponds to an elevated, shallow-water depositional environment of the Lochkovian-Pragian boundary beds, with a depth of deposition of a few tens of metres. Coarse-grained bioclastic limestones represent taluses of sand-sized biogenic detritus at the margins of the elevated areas. Crinoid biostromes served as a source of the organic detritus that was transported further basinwards.

All types of dolomitization and silicification mentioned in previous papers on these beds were found and described in the present study. Early diagenetic changes occurred mainly in the micritic matrix, while late diagenetic alterations are present in fractures, stylolites, and bioclast voids.

FeO, MgO, and insoluble residues show a positive correlation in the micritic and biomicritic limestones of deep marine development.

This paper also shows that Wilson's microfacies analysis is applicable to the Early Palaeozoic carbonates of the Barrandian area.

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