nen Osthang Hofberg 675 m, vier Kilometer nordöstlich von Ottokönigen, und Flucht 670 m, dreieinhalb Kilometer nordwestlich Ottokönigen, zeigen eine deutlich andere Verteilung von „quarzreiche Gesteine“ zu „Gneise“ zu „Karbonate“. Die beiden letztgenannten Aufschlüsse liegen nach Geländebefund an der Basis der Hausruckschotter. Ob die Konglomeratlagen gleicher Geröllgesteins-Verteilung leicht diskordant die Tonschichten anschneiden, welche während der Geländearbeit die wichtigsten Leithorizonte sind, wäre noch zu prüfen.

Blatt 68 Kirchdorf an der Krems

Bericht 1994 über geologische Aufnahmen in den Nördlichen Kalkalpen auf Blatt 68 Kirchdorf an der Krems

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The area covered by the 1 : 10,000 geological map is delimited from the east, between Steyrleithen and Oberleonstein, by the Steyr River. The line Schnitzlhub (Oberleonstein) – Rinnerberger Bach/Rinnerberg west slope, is its southern boundary. From the west and north, the map limit runs from Rinnerberg/Grabmais to the upper part of Priethal (Haindlmühlbach), then continues along Pernzell valley to Steyrleithen.

The area was geologically mapped in 1948–49 by F. BAUER (1953: Der Kalkalpenbau im Bereiche des Krems- und Steyrtales in Oberösterreich. – Skizzen zum Antlitz der Erde, 107–130). BAUERS map in scale 1 : 12,500 (largely without Quaternary cover) and explanatory text was the basis for the present revision. Its interpretative part has been restricted solely to tracing numerous SW–NE-trending faults which play an important part in the distribution of particular lithostratigraphic and tectonic units, and in the morphology of the area.

The map area represents the northern margin of the Limestone Alps at their contact with the Rhenodanubian Flysch zone. Following BAUER (1953), two facial-tectonic zones of the Limestone Alps were distinguished: the Ternberg Zone in the north, thrust over the Flysch, and the Reichraming Zone in the south, thrust over the Ternberg Zone. Two post-Neocomian nappes were distinguished by the present author in the Ternberg Zone: the Lower Ternberg Nappe (LTN), and the Upper Ternberg Nappe (UTN). A wide zone of tectonic breccias separates the Ternberg nappes from the Reichraming Nappe (RN).

Rhenodanubian Flysch

This is the lowest tectonic unit of the area, bordering the Limestone Alps from the north. The contact between these units is strongly affected by post-nappe strike-slip SW-NE-trending faults. The overthrusting of the Limestone Alps nappes post-dates the flysch deposits in which three lithostratigraphic units may be distinguished (stratigraphic ranges after H. EGGER [1992, Zt. dt. geol. Ges., **143**, 51-65; 1993, Zitteliana, **20**, 59-65]).

The oldest unit, several hundred m thick, correlating with the Gaultflysch (Albian), crops out in the northern part of the area. It consists of bluish to greenish, laminated, thin-bedded siliceous sandstones with subordinate shale. Poorly exposed red or variegated shales (10–20 m), correlating with the Untere Bunte Mergel (Cenomanian), separate the Gaultflysch from a younger flysch complex of bluish, thin- to medium-bedded siliceous sandstones with blue shale/marl intercalations. The latter unit, correlatable with the Zementmergelserie (Lower Senonian) is exposed further south-west along lateral strike-slip contact which divides the Flysch from the Limestone Alps.

Lower Ternberg Nappe (LTN)

This unit is best exposed between Plachwitz and Rinnerberg in the south, and includes Gr. Landsberg in the north. It consists mainly of Triassic carbonates: Dachsteinkalk, Hauptdolomit, Wetterstein Limestone and Reifling Limestone (with cherts), altogether 800–900 m thick. Upper Triassic units (Kössenerschichten, Oberrhätkalk) are missing, and the Liassic transgresses directly over either the Hauptdolomit or the Dachsteinkalk.

The Lower Jurassic (Liassic) through Neocomian succession is very condensed in thickness (30–70 m) and restricted in areal extension. It consists of carbonates which were deposited in open sea conditions on the outer shelf and upper slope of an intra-oceanic ridge that derived from the fragmented Triassic carbonate platform. This platform was block-faulted and strongly eroded at the Triassic/Jurassic boundary, during Palaeocimmerian movements.

The basal Liassic beds consist of massive, subcrystalline, whitish, yellowish to pink limestones 10–23 m thick, resting directly (without basal conglomerate) upon the Hauptdolomit or Dachsteinkalk. The massive limestones locally pass into grey to yellowish crinoidal limestone (Hierlatzkalk facies), sometimes they become grey, spotty limestones, resembling the Liassic Fleckenkalk facies.

There follow red, massive to thin-bedded and nodular limestones (ammonitico rosso facies), 5–10 m, sometimes up to 20 m thick. Stratigraphically, they probably represent the Upper Liassic (Adneterkalk facies), Dogger and Lower Malm (up to ?Kimmeridgian) inclusively (Klauskalk facies). These limestones may be locally partly replaced by Dogger-type white crinoidal limestone 10 m thick (Vilserkalk facies).

In continuity with the red nodular limestones come light-grey to greenish, thin-bedded, slightly marly, often spotty limestones with thin marl intercalations. These beds, 10–15 m thick, correspond to Tithonian and Lower Neocomian (Aptychenkalk vel Biancone vel Matolica facies). The succession ends with green marls and marly limestones 5–10 m thick (higher Neocomian).

The LTN is strongly internally folded and traversed by numerous second-order thrust-planes that divide the nappe into north-vergent thrust-scales and thrust-folds. They usually show tectonically reversed succession of strata. A system of SW–NE-trending faults displace the LTN together with its substratum (Flysch) and the superstratum (UTN).

Upper Ternberg Nappe [UTN)

The UTN occurs in two main areas: between Rinnerberg and Priethal (Haindlmühlbach) in the south, and at Kl. Landsberg in the north. These areas are separated by an upthrust block of the LTN at Gr. Landsberg.

The nappe consists mainly of Jurassic rocks; the uppermost Triassic and Lower Cretaceous rocks are encountered only locally. The nappe is characterized by a deep-water development of the Jurassic through Neocomian succession which is much thicker (140–180 m) than more shallow-marine development of equivalent strata in the LTN (30–70 m). There is a slight change in the character and succession of the Lower Jurassic through Lower Cretaceous (Neocomian) strata in the UTN between its southern (Rinnerberg – Priethal) and northern (Kl. Landsberg) exposures: the latter area represents a more shallow development (appearance of better developed Dogger crinoidal limestones).

The stratigraphic succession of the UTN starts with dark carbonates (marls and limestones) of restricted, poorly aerated (anoxic/dysoxic) basin characteristics (Kössenerschichten and Allgäuschichten), that probably followed directly, and without a break, upon the Triassic platform carbonates (probably Dachsteinkalk). These basal incompetent beds were the gliding medium for the nappe which was detached from its carbonate Triassic substratum.

Fossiliferous Kössener Schichten, represented by black to grey-yellowish thin-bedded limestone and coquina are seldom exposed, and known mainly from loose fragments in landslides and slope scree. Their thickness is unknown, certainly much smaller than accepted by BAUER (1953).

The Liassic is represented by dark-grey to light-brownish spotty marly limestones and marls (Fleckenmergel/ Fleckenkalk facies), several tens of m thick, with an ammonite fauna (BAUER, 1953) indicating Late Sinemurian and Pliensbachian ages. The rocks pass upwards into grey, spotty siliceous (cherty) limestones and cherts (spongolites) about 55 m thick (Upper Lias).

Locally developed, whitish to light grey, fine-grained crinoid limestones 10-15 m thick, may correspond to Dogger (Vilserkalk facies).

There follow green (older) and red (younger) radiolarites and siliceous radiolarian limestones. Being incompetent rocks, contained between massive competent limestones, the radiolarites are often tectonically reduced in thickness or even wedge out completely. Their maximum thickness probably does not exceed 5 m. The radiolarites mark the deepest, open-oceanic stage of basin development; they were deposited at depths below (green radiolarites) or close to (red radiolarites) the Oxfordian CCD.

Appearance of red, ammonitico rosso-type, massive to nodular limestone (Kimmeridgian–Tithonian) 5-10 m thick, indicates slight shallowing of the oceanic basin bottom, its sedimentary environment corresponding to upper/middle submarine slope.

There is an upward transition of the red limestone into white, subpelitic, Calpionellid-bearing pelagic limestones of the Tithonian (resp. Upper Tithonian–Berriasian). These limestones, deposited probably at depths comparable with outer shelf/shelfbreak, reach up to 100 m in thickness. They represent an intra-oceanic carbonate platform.

A break in sedimentation of subpelitic limestones, caused by positive movements of the sea bottom, was recognised at the top of the Tithonian platform deposits. Tension cracks that opened as a result of uplifting (Neocimmerian phase), penetrated the limestone platform down for several tens of metres. They were subsequently filled with (neptunian dykes and nests), and covered by (a layer 2–3 m thick) red, often crinoid limestone. This evidences carbonate platform collapse to greater depths during the Neocomian.

There follows whitish, often spotty, bedded limestone, with black to brownish chert nodules (Biancone resp. Maiolica facies), corresponding to higher Neocomian. Its thickness is about 10 m.

The youngest strata (probably highest Neocomian), a minimum 10 m thick (probably up to several tens of meters thick), are represented by green-grey marls and marly limestones, with thin intercalations of grey, fine-grained sandstones.

The UTN is much less folded than the underlying LTN, its basal thrust surface is often subhorizontally cutting through steeply folded Triassic–Neocomian rocks of the LTN.

The UTN is involved in the same system of north-vergent tectonic scales and thrust-folds that dismember the LTN, likewise it is displaced by the SW-NE-trending faults that cut through the whole structure (Flysch, LTN, UTN, RN).

Reichraming Nappe (RN)

This tectonic unit consists in the area mapped in 1994 entirely of Triassic carbonate rocks. Near Oberleonstein, in a tectonically reversed succession, occurs the Gutenstein Limestone (over 100 m), the Gutenstein Dolostone (about 200 m), the Reifling Limestone with chert nodules (150–200 m), the Hauptdolomit (a minimum of 200 m) and the Dachsteinkalk (100–l5O m).

The contact between the RN and the Ternberg Zone (UTN and LTN) units is strongly sheared, with several zones of cavernously weathered tectonic carbonate breccias, up to 20–30 m thick each.

Faulting

A system of dense, SW-NE-trending strike-slip faults traverses the area of the Limestone Alps between Oberleonstein in the south and Kl. Landsberg in the north. The faults are easily traceable in the Jurassic and in the majority of Triassic rocks. Their strike-slip character is proven at the westernmost end of the Kl. Landsberg Jurassic limestone ridge, where we see horizontal tectonic striations cutting through S-dipping crinoid limestone (Dogger) and red nodular limestone (Malm); the striations are well marked at an exposed fault surface that plunges westward at 70 degrees.

The SW–NE-trending contact of the Limestone Alps with the Flysch along Pernzell, and further south, is a complex stepwise strike-slip fault zone involving both megaunits, with tectonic wedges of the Flysch sandstones incorporated within the Lower Jurassic rocks.

This fault system post-dates both the nappes of the Ternberg Zone (LTN, UTN) and the Reichraming Zone (RN), and the Flysch Nappe, and may be an expression of Tertiary faulting (see BIRKENMAJER, 1993, Jb. Geol. B.-A., **195**, 580-581).

Quaternary Deposits and Forms,
Karst Phenomena

Four successive Pleistocene fluvial accumulation covers (terraces) consisting of usually well-cemented carbonate gravel, 2-5 m thick, and with bedrock base, were distinguished in the Steyr River valley and its left tributaries.

Three successive, mainly erosional, terrace ledges/terraces, sometimes with thin gravel cover, were attributed to the Holocene. They cut into Pleistocene gravel accumulations, sometimes also into the bedrock.

Weathering clays are widely distributed, particularly in the Flysch zone at its contact with the Limestone Alps, and over softer rocks of the latter (Neocomian marls and some Hauptdolomit varieties). Rock debris (talus, talus cones and stone flelds) rim most of the harder rock exposures in the Limestone Alps. Landslides are formed in both the weathering clay and rock debris covers.

Karst phenomena are not particularly conspicuous in the area mapped. Small caves/rock shelters developed mainly in Tithonian limestones of the UTN and in the Hauptdolomit. Active karst sinks and less active polja are encountered mainly in the outcrops of the Dachsteinkalk and Hauptdolomit, being marked in talus, weathering clays and terrace accumulation.

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A detailed explanation of the geological map 1 : 10.000 is stored in the Scientific Archive of the Geologische Bundesanstalt.

Blatt 91 St. Johann in Tirol

Bericht 1993/1994 über paläontologische und biostratigraphische Untersuchungen von Brachiopoden der Steinplatte auf Blatt 91 St. Johann in Tirol

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The collecting and study in the classical area of the Upper Triassic Steinplatte "reef" was focused on the brachiopods coming from the "reef" limestones. At the same time, the attempt was made to find possible differences between brachiopod assemblages of these limestones and of the neighbouring basinal Kössen Beds.

On the western side of the Steinplatte complex the collection was made in the A- and B-reefs sensu OHLEN (1959) (= A-, B- mounds in PILLER, 1981). The lower parts of these mounds are represented according to PILLER, 1981 by bedded terrigenous limestones with bivalve-coral-hydrozoan assemblages. These limestones contain the richest brachiopod fauna. The upper parts of the mounds are mostly perpendicular walls. Due to their massive character, lesser terrigenous content and also access, these limestones have yielded only rare brachiopod specimens till now (e.g. *"Rhynchonella" subrimosa* sensu SUESS in the mound A). Lower bedded limestones of mound A contain *Fissirhynchia fissicostata, Austrirhynchia cornigera, Rhaetina gregaria, Rhaetina pyriformis, Triadithyris gregariaeformis, Zeilleria norica, Thecospira haidingeri, Zugmayerella uncinata* and *Zugmayerella koessenensis*. Similar limestones of mound B yielded *Fissirhynchia fissicostata, Austrirhynchia cornigera, Rhaetina gregaria, Rh. pyriformis, Zeilleria norica* and *Zugmayerella* sp. A very interesting mound was ascertained 1994 about 150 m S of Köhrgatterl showing well the passage to the typical Kössen Beds, with relatively abundant brachiopod fauna. Lowermost bedded limestones of this mound contained big terebratulids *Rhaetina pyriformis*, then *Fissirhynchia fissicostata, Austrirhynchia cornigera, Zeilleria norica, Zeilleria elliptica* and *Zugmayerella uncinata*. Overlying massive limestone yielded one specimen of *Austrirhynchia cornigera* and *Zeilleria* sp. In the poorly bedded, nodulous limestones of the Kössen type in the southernmost parts of the section the following species were ascertained: *Fissirhynchia fissicostata, Austrirhynchia cornigera, Rhaetina pyriformis, Zeilleria norica, Z. austriaca, Z. elliptica* and *Zugmayerella koessenensis*. The locality in the light-grey limestones near the down-hill run N of the Plattenkogel (capping facies of the "Oberrhätkalk" sensu STANTON & FLÜGEL, 1989) yielded *Fissirhynchia fissicostata, "Rhynchonella" subrimosa* sensu SUESS, *Rhaetina pyriformis, Zeilleria norica, Z. austriaca, Oxycolpella oxycolpos, Zugmayerella uncinata, Zugm. koessenensis and Laballa suessi*.

Limestone layers in the middle and upper parts of the Kössen Beds near the Köhrgatterl (locality 2 "Untere Kössener Schichten" in E. KRISTAN-TOLLMANN et al., 1991) contained *Fissirhynchia fissicostata, Rhaetina pyriformis, Zeilleria norica, Z. austriaca, Oxycolpella oxycolpos, Sinucosta emmrichi* and *Zugmayerella koessenensis*. About 90 m from this locality a small occurrence of the Kössen limestone was ascertained near the road to Stallenalm, with lumachelles of *Zugmayerella uncinata*, accompanied with some specimens of *Fissirhynchia fissicostata, Zeilleria elliptica* and *Zugmayerella koessenensis*. The Kössen Beds overlying the mound A (locality 5 "Untere Kössener Schichten" in E. KRISTAN-TOLLMANN et al., 1991) yielded following brachiopods: *Fissirhynchia fissicostata, Rhaetina pyriformis, Zeilleria norica* and *Oxycolpella oxycolpos* in the limestone layers, and *Fissirhynchia fissicostata* and *Zeilleria elliptica* in the marly intercalations. In the Kössen Beds just above the mound B *Fissirhynchia fissicostata, Rhaetina pyriformis* and *Oxycolpella oxycolpos* were found.

The older literary data on brachiopods from Steinplatte referred practically only to the Kössen Beds (F.F. HAHN, 1910; W. VORTISCH, 1926; J. KUSS, 1983). It is interesting that none of these authors mentioned *Austrirhynchia cornigera* – the only brachiopod species considered in the recent literature characteristic of the Rhaetian s.s. Basing on the present study, it seems that there is no great difference between average brachiopod assemblages of the "Oberrhät- kalk" and Kössen Beds on Steinplatte.

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