DEFINITION OF THE MIDDLE TO LATE JURASSIC CARBONATE CLASTIC RADIOLARITIC FLYSCH BASINS IN THE NORTHERN CALCAREOUS ALPS

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In the Northern Calcareous Alps different carbonate clastic radiolaritic flysch basins are formed in sequence due to the closure of the Tethys Ocean. The Basins were defined: 1) Lammer Basin; Callovian to Oxfordian; containing the Hallstatt Mélange (mass-flow deposits and slides). 2) Tauglboden Basin; Oxfordian to Tithonian; containing mass-flow deposits and slides from nearby topographic rises. 3) Sillenkopf Basin; Kimmeridgian to ?Tithonian; mass-flow deposits with mixed origin.

Keywords: Northern Calcareous Alps, radiolarite basins, Middle and Late Jurassic, Lammer Basin, Tauglboden Basin, Sillenkopf Basin

The sedimentation pattern in the Northern Calcareous Alps dramatically changed around the Middle/Late Jurassic boundary (Callovian-Oxfordian). Significant sedimentation resumed with the deposition of radiolarian chert (Ruhpolding Formation), which documents the change to almost purely siliceous sediments controlled by the oceanographic evolution in the Tethys. From the Bathonian/Callovian boundary on, the sedimentary evolution in the southern part (Lammer Basin with mass-flow deposits and large slides originated from the Hallstatt Zone) clearly differed from that in the northern part (later Trattberg Rise and Tauglboden Basin – Oxfordian/Kimmeridgian boundary to Early Tithonian). The main difference is the earlier onset and different composition of huge mass flows in the Lammer Basin, which suggests generation of a substantial local relief. Another type of radiolarite basins is formed in Kimmeridgian in the southern Northern Calcareus Alps south of the Lammer Basin, called Sillenkopf Basin (Kimmeridgian to ?Early Tithonian).

The origin and geodynamic significance of basins formed in the Late Jurassic have been controversely disputed for decades, mainly because the respective tectonic structures were largely overprinted during the later deformations. New detailed studies during the last decade

have provided new data on facies and ages of the sedimentary succession and the source areas of redeposited sediments.

As shown in the central Northern Calcareus Alps, the Middle to Late Jurassic basin evolution is the key to unterstand the tectonic evolution. A significant increase in the sedimentation rate occurred with the deposition of radiolarian chert (Ruhpolding Formation) in the Early Callovian and the formation of new, elongate, W-E striking basins (Lammer Basin, Tauglboden Basin) with carbonate clastic radiolaritic flysch sequences, separated by a structural high (Trattberg Rise). The Lammer and Tauglboden basins formed in sequence indicating migration of tectonic activity: the older Lammer Basin (Early Callovian-Middle/Late Oxfordian) in the southern part of the Tirolic unit contains mass-flows and slides originated in the Hallstatt facies zone (= Hallstatt Mélange, belonging to the Tirolic unit; the Hallstatt unit as a source area has been completely eroded); the younger Tauglboden Basin (Oxfordian/Kimmeridgian boundary to Early Tithonian) in the northern part of the Tirolic unit contains mass-flows and slides originated from a nearby topographic rise (Trattberg Rise). These basins are interpreted as deep-sea trenches in front of advancing nappes related to the closure of parts of the Tethys Ocean. Another radiolarite basin (Sillenkopf Basin: Kimmeridgian and younger) is formed in the southern part of the Lammer Basin and south of it and is related to out-of-sequence shortening. The Sillenkopf Basin shows a similar age range as the Tauglboden Basin but differs completely in the components of the mass-flow deposits. This implies a polyphase genesis of the radiolarite basins in the central parts of the Northern Calcareous Alps. All basins contain carbonate clastic radiolaritic flysch.

Definition of the Basins

Lammer Basin

Sediments: cherty sediments with mass-flow deposits and allochthonous slides, Strubberg Formation.

Age of the Strubberg Formation: Early Callovian to middle Oxfordian (dated by radiolarians).

Underlying sediments: red nodular limestones of the Klaus Formation.

Type area: Lammer valley east of Golling.

Type section: Sattlberg section.

The Lammer Basin contains a more than 1.5 km thick series of Callovian/Oxfordian deep-water cherts and shales intercalated with breccias, mega-olistoliths and slides (Strubberg Formation). This trough was formed in the former area of the Late Triassic lagoonal carbonate

platform. The redeposited rocks were derived from the continental margin along the southern rim of the Northern Calcareous Alps (Dachstein reef tract and Hallstatt Zone).
The basin fill is composed of Callovian/early Oxfordian deep-water sediments, which contain different types of mass-flow deposits and large slide masses in the early and middle Oxfordian. Examination of the stratigraphy and facies of the resedimented clasts and blocks suggests that the Hallstatt Zone and adjacent facies strips (Dachstein reef tract, Pötschen Formation, Hallstatt limestones, Meliaticum) were destroyed and that their Triassic to Liassic sediments were eroded or mobilized as slides and redeposited in the Lammer Basin. Sediment redepostion ended in the Lammer Basin in the late Oxfordian, contemporaneous with the formation of the Trattberg Rise and the Tauglboden Basin to the north. After a sedimentation gap in the Kimmeridgian, pelagic limestones of the Oberalm Formation were deposited on top of several slide masses.
The Lammer Basin stretches from the Berchtesgaden area in the west (former Berchtesgaden-Kühroint Basin) to the area of Bad Mitterndorf in the east (sediments were formerly mostly dated as Liassic Allgäu Formation).

Tauglboden Basin
Sediments: cherty sediments with mass-flow deposits and parautochthonous slides derived from adjacent highs (Trattberg Rise), Tauglboden Formation.
Age of the Tauglboden Formation: Oxfordian/Kimmeridgian-boundary to Early Tithonian (dated by radiolarians).
Underlying sediments: radiolarites of the Ruhpolding Formation, partly Late Oxfordian (red radiolarite).
Type area: Tauglboden valley east of Kuchl.
Type section: Kesselwand section.
In this basin, the lower part of the radiolarien chert (black and red radiolarite) is unaffected by gravitative resedimentation. The gravitative resedimentation from the rise started during a later phase of radiolarien chert deposition contemporaneous with the formation of the Tauglboden Basin (in the Kimmeridgian), i.e. later than in the Lammer Basin. The Kimmeridgian to early Tithonian Tauglboden Formation attains a thickness of about 500 m near the depocenter in the southern part of the asymmetric Tauglboden Basin. It consists of resedimented and pelagic limestones, turbidites, grain flow deposits, and slides. They contain clasts of Late Triassic to Oxfordian age derived from the adjacent Trattberg Rise to the south = local material (e.g. Dachstein limestone, Kössen beds, Adnet limestone, Klaus limestone,

limestones of the Allgäu Formation, radiolarite). The mass flows show a south-to-north change from proximal to distal facies. Flute casts, imbrications, and slumping also indicate transport from southerly directions.

The Tauglboden Basin stretches from the Unken area in the west (former Schwendt-Glasenbach Basin) to the area of Bad Ischl in the east (sediments were formerly mostly dated as Liassic Allgäu Formation).

Sillenkopf Basin

Sediments: cherty sediments with mass-flow deposits and allochthonous slides Sillenkopf Formation.

Age of the Sillenkopf Formation: Early Kimmeridgian to Tithonian (dated by radiolarians, foraminifers and algae).

Underlying sediments: Strubberg Formation, age: partly Callovian to Middle Oxfordian, radiolarites of the Ruhpolding Formation: Late Oxfordian (red radiolarite).

Type area: Northern rim of Hagengebirge and Steinernes Meer south of Berchtesgaden.

Type section: Sillenkopf section.

The Sillenkopf Basin contains mass-flow deposits in the late Kimmeridgian (dated by resedimented shallow-water components) with: 1. Dolomites and limestones of the Pötschen Formation, Late Triassic. 2. Cherty sediments of the Ruhpolding Formation 3. Late Kimmeridgian shallow-water carbonates. 4. Protoglobigerina-wackestones, Klaus Formation. 5. Carbonate-cemented sandstones. 6. Crystalline components. 7. Haselgebirge (salt-clay mudstone, gypsum), Permian. 8. Magmatic quarz. The stratigraphic range of the cherty sediments of the Sillenkopf Formation (cherty limestones and radiolarites) is therefore equivalent to the Tauglboden Formation. The pebbles of these mass-flow deposits are completely different to those of the Tauglboden Formation, where the components derived from the Trattberg Rise = local material from the late Triassic lagoonal facies belt of the Northern Calcareous Alps.

The Sillenkopf Basin is exposed in the southern Berchtesgaden Alps and southern Salzburg Calcareous Alps (former Hagengebirge-Lammer Basin) (sediments were formerly mostly dated as Tauglboden Formation).

Fig. 1. Sedimentary sequences of the Lammer, Tauglboden and Sillenkopf Basin. The thickness of the sedimentary sequence in the Lammer Basin contain is 1500-2000 m, in the Tauglboden Basin nearby 1200 m (including the Oberalm Formation), the Sillenkopf Basin shows only remnants of 60-100 m.

Sedimentary Basin Fills

North

South