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NEW DATA TO THE DIAGENETIC TO METAMORPHIC PATTERNS IN THE EASTERN AND CENTRAL NORTHERN CALCAREOUS ALPS

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We determine the diagenetic and metamorphic overprint in the eastern and the middle part of the Northern Calcareous Alps, especially the Hallstatt Mélange = „Juvavic units“ and use these data to reconstruct the Jurassic and Cretaceous thermal and tectonic history of the western parts of the Tethys domain.

To reconstruct the Mesozoic thermal history, the knowledge of the paleogeographic position of the tectonic units is of special interest. Therefore, diagenetic/metamorphic patterns (together with geochronological, facies and stratigraphical data) are used to reconstruct the relative position of nappes at the time of maximum heating and to subdivide nappe complexes. This is especially important in the eastern and middle part of the Northern Calcareous Alps, whose tectonic styles and paleogeographic positions are still debated controversial.

The temperature reconstruction based mainly on CAI data, because in the eastern and central Northern Calcareous Alps carbonates are the most common rocks. The latter is considered especially promising, because Triassic carbonates are the most important lithologies within the Northern Calcareous Alps.

Conodont colour alteration (CAI) studies reflect the polyphase tectonic history by a polyphase thermal history and show two distinct units with a sharp CAI boundary. For our reconstruction we find conodonts in the whole Triassic and resedimented as slides and pebbles in Jurassic and Cretaceous deep water sediments. These resedimented triassic pebbles and clasts in a matrix with low or no thermal overprint allow to determine resedimented triassic rocks with thermal overprint (transported thermal overprint).

The southern unit and parts of the Hallstatt Mélange show strong alteration (CAI 5.5-6.0, partly CAI 7.0; e. g. Hochkönig, Grimming, Mandling unit) with even local CAI inversions (e. g. Hochkönig). The highest metamorphism (CAI >5.5) is transported and predates the Upper Jurassic gravitational tectonic emplacement of the Hallstatt mélange and the metamorphic unit onto the Upper Tirolicum in late Middle early Upper Jurassic times (late Callovian to early Oxfordian). The high CAI values are related to tectonic burial in an accretionary wedge formed during the closure of the Tethys Ocean. The northern units (= Bavaric, Tirolic nappes) show a relatively homogeneous distribution of no or low grade conodont alteration (CAI 1.0-2.0) increasing to the south and crossing nappe boundaries. This thermal overprint can be date younger as Kimmeridgian and older as Berremian. Another thermal overprint is related to metamorphism of the crystalline basement in the middle Cretaceous and affected parts of the southern rim of the Northern Calcareous Alps with a continuous south to north and bottom to top decrease in temperature and with medium CAI values in the south (CAI 3.0-4.0, partly CAI 5.0).

This corresponds with the polyphase diachronous metamorphic history in the Austroalpine basement. A first metamorphic cycle, which included high-pressure metamorphism in the Hallstatt zone, yielded radiometric ages roughly between 160 and 130 Ma. This event affected the Greywacke Zone and its Paleozoic equivalents and parts of the Northern Calcareous Alps. With CAI investigations we can subdivide this cycle in a) transported slides and pebbles and b) in situ thermal overprint after the emplacement of the Hallstatt Mélange = „Juvavicum“.

The second cycle, which includes high-pressure metamorphism in the crystalline basement, embraces ages from roughly 110 to 80 Ma. It is found in the Austroalpine crystalline

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basement and overprinted Paleozoic terrains and the southern parts (including Hallstatt limestones – W. Frank, unpublished) of the Northern Calcareous Alps.
We former investigate units with strong alteration of the central and eastern part of the Northern Calcareous Alps (e.g., Hochkönig, Mürzalpen unit), partly with CAI inversions, locations with metamorphic blocks and slides in Upper Jurassic carbonate clastic radiolaritc flysch basins, areas with backthrusting and imbrication of the CAI-zones with tectonic shortening (e.g. southern part of the Dachstein block) and areas with medium CAI values with south to north and bottom to top decrease in temperature (e.g. Schneealpen unit, Salzburg and Berchtesgaden area). In some parts of the Northern Calcareous Alps the CAI-zones are destroyed by Miocene lateral tectonic extrusion.
The mapping of detailed CAI zones is important for the reconstruction of the paleogeographic and tectonic configuration in Upper Jurassic and Cretaceous times and helps to understand the recent block puzzle of the Northern Calcareous Alps. For example, unknown tectonic boundaries can localized and „classical“ stratigraphic successions can shown as tectonic imbrication. The emplacement of some slides with CAI values of CAI 1.0 (e.g. Blühnbachtal area, Rettenstein, Hüpfliger slides) is younger than the youngest metamorphic overprint of the southern rim of the Northern Calcareous Alps and may related to Miocene lateral tectonic extrusion. By mapping of the zones we can estimate lateral movements, block rotations. By using CAI data we can show a stronger tectonic shortening along the southern rim of the Northern Calcareous Alps as known. Two styles are known: northern thrusting with inverse CAI imbricates (e.g. Hochkönig but only manifested by few conodont samples in the moment) and southern thrusting (e.g. Dachstein unit).
On base of our newest results, for Jurassic and early Cretaceous times we can distinguish three thermal overprints in the middle and eastern NCA confirmed by stratigraphic and geochronological data:

1. A thermal overprint older than Oxfordian or Kimmeridgian: some slides with high CAI-values (CAI 6.0-7.0) are incorporated in late Jurassic radiolarites in areas with low or no thermal overprint. This thermal overprint affects the slides and mass-flow components south of their present position before their emplacement in the late Jurassic radiolarite basins and show middle to late Jurassic tectonic shortening and mobilization south the present southern rim of the NCA,
2. A thermal overprint younger than Oxfordian to Kimmeridgian after the emplacement of the „Juvavicum“ and older than Hauterivian. This thermal overprint cross the Oxfordian/Kimmeridgian slide and nappe boundaries and affects also the late Jurassic matrix. This thermal overprint produces CAI-values of CAI 1.5 in the northern Hallstatt Mélange = „Juvavicum“ and max. CAI 5.0 in the southern part. Resedimented slides and blocks of this thermal event we find resedimented in Hauterivian flyschoid sediments showing the ongoing tectonic shortening in early Cretaceous times,
3. A thermal overprint, which is very well dated by geochronological investigations as pre-gosauic (100-90 Mio. a) affecting the southern rim of the NCA.

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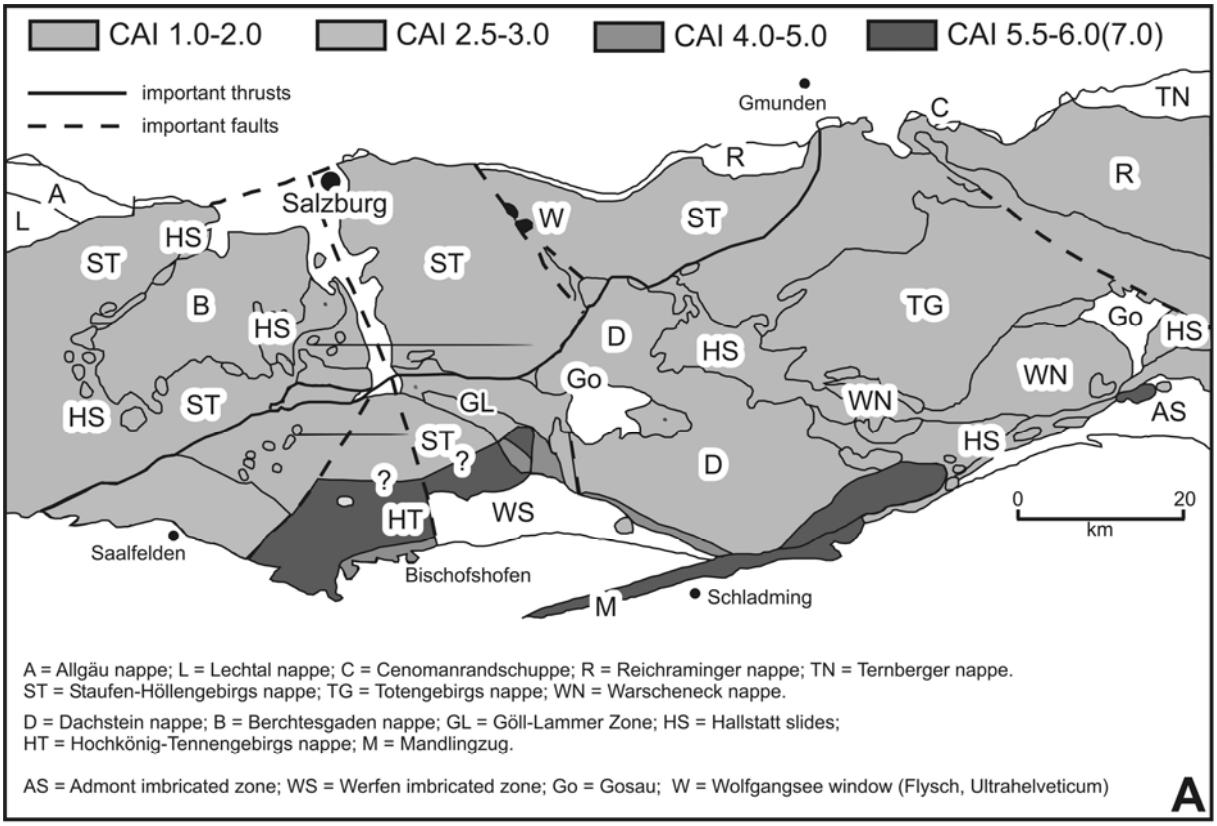

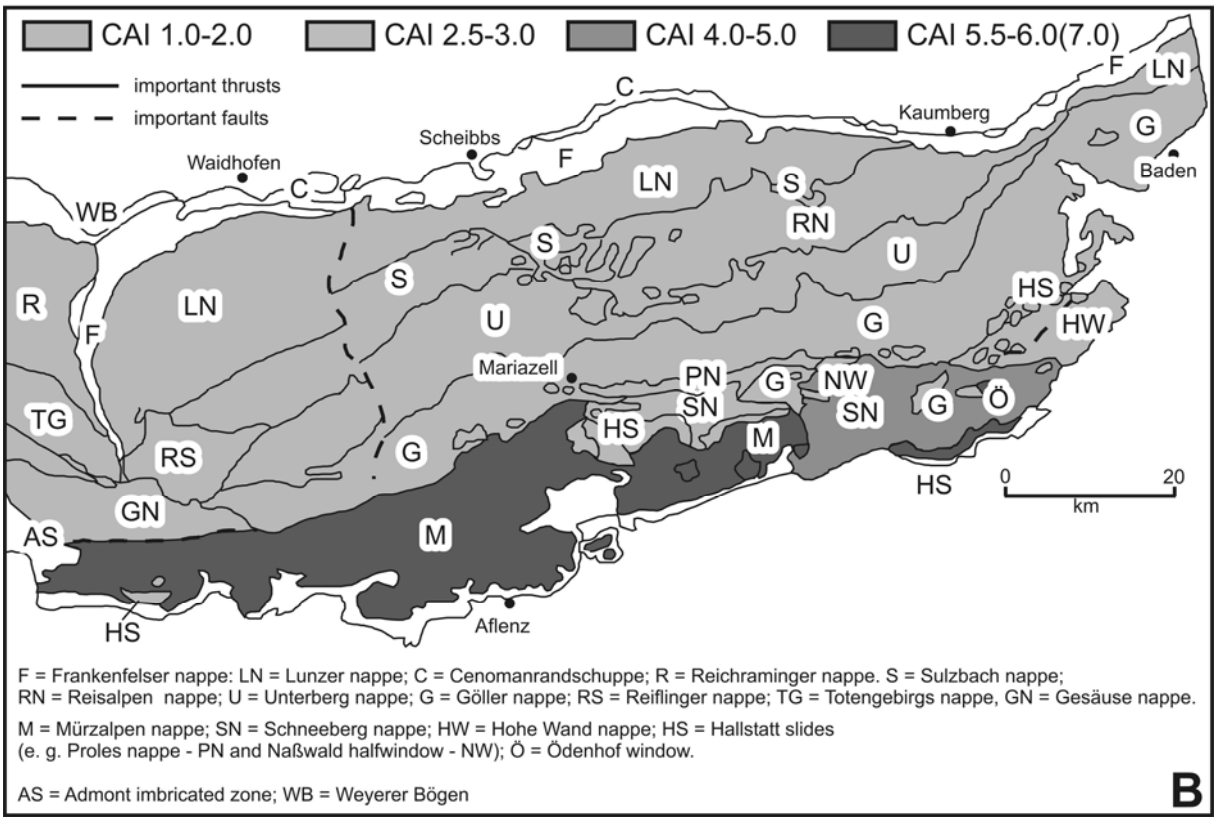

Fig. 1: CAI maps on base of tectonic maps of TOLLMANN (1985).

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