CONODONT COLOUR ALTERATION INDICES (CAI) IN THE CENTRAL WESTERN CARPATHIANS AND THE NORTHERN CALCAREOUS ALPS — A COMPARISON

H.J. GAWLICK[1], M. HAVRILA[2], L. KRYSTYN[3], R. LEIN[4] and J. MELLO[2]

[1]*Montanuniversität Leoben, Institut für Geowissenschaften: Prospektion und Angewandte Sedimentologie, Peter–Tunner–Straße 5, 8700 Leoben, Austria*

[2]*Geological Survey of Slovak Republic, Mlynská dolina 1, 81704 Bratislava, Slovakia*

[3]*Universität Wien, Institut für Paläontologie, Geozentrum Althanstraße, 1090 Wien, Austria*

[4]*Universität Wien, Institut für Geologie, Geozentrum Althanstraße, 1090 Wien, Austria*

Abstract: Conodont Colour Alteration (CAI) investigations in the Central Western Carpathians (= CWC) and in the Northern Calcareous Alps (= NCA) shows a lot of similarities in both regions. We can distinguish two tectonic units with a sharp CAI boundary: northern units – low alteration with CAI 1.0–2.0; southern units – strong alteration with CAI 5.5–6.0, partly CAI 7.0. By comparision of the CAI indices and the tectonic style we interpret the strong alteration in the Central Western Carpathian as transported like in the Northern Calcareous Alps.

Key words: Central Western Carpathians, Northern Calcareous Alps, Conodont Colour Alteration Indices (CAI)

Northern Calcareous Alps

In the Northern Calcareous Alps Conodont Colour Alteration (CAI) studies reflect a polyphase thermal history and show two distinct units with a sharp CAI boundary (GAWLICK et al., 1994). The southern unit (metamorphic 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). The highest metamorphism (CAI > 5.5) is transported and predates the Upper Jurassic gravitational tectonic emplacement of the Hallstatt Mélange, resp. nappes and the ”metamorphic unit” (= Hochkönig, southern part of Tennengebirge) onto the Tirolicum in late Middle to 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 parts of the Tethys Ocean. The northern units (= Bavaric and Tirolic nappes) exhibit a relatively homogeneous distribution of no or low grade conodont alteration (CAI 1.0–2.0) increasing to the south thereby crossing the nappe boundaries between the Tirolicum and the Hallstatt Mélange. This thermal overprint is younger than Kimmeridgian and older than Barremian. Another thermal overprint is related to metamorphism of the crystalline basement in the Middle Cretaceous and affects parts of the southern rim of the NCA 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, locally CAI 5.0) (GAWLICK et al., 2001).

Those data corresponds with the polyphase diachronous metamorphic history in the Austroalpine basement. A first metamorphic cycle which produced 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. 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 basement and overprinted Paleozoic terrains and the southern parts of the Northern Calcareous Alps.

In contrary to the highly differenciated CAI-patterns in the NCA the sedimentary cover nappe systems of Lower and Middle Austroalpine origin show an uniform high thermal alteration (CAI 5.5–7.0)

Western Carpathians

A correlation between the NCA and the CWC is hampered by the fact of their different recent spatially distribution: The NCA display a continous sheet, totally overthrusted across the metamorphic nappes in Lower- and Middle Austroalpine position, now resting on Neogene sediments of the Molasse Foredeep, whereas the tectonic counterparts of the NCA in the CWC are composed of isolated outcrops laying on metamorphic units (Tatricum, Veporicum) in an internal position. Secondly, a different level of the alpine Mesozoic nappe pile is exposed in both regions.

In spite of this different configuration of the recent propagation of the NCA and the CWC similar trends in the zonation of their thermal alteration (CAI values) can be recognized.

1) The **Hronic Nappe System** with generally low thermal alteration shows an internal zonation similar to that of the homologous units in the NCA. Similar to the thermal alteration in the Bavaric- and Tirolic nappe systems in the NCA a slight increase of the thermal overprint from bottom to top and from north (west) to south (east) can be recognized in the Hronic nappe pile, showing the lowest CAI values in the Ostrá-Malenica nappe (CAI 1.0–1.5) and in the Stražov nappe (CAI 1.0) and the highest values in the Svarín nappe (CAI 2.0–2.5).

The CAI grade, however, obviously depends on further factors. It is shown, for instance, that in proximity of overthrust planes or tectonic zones the values are higher (as an example the

base of the Svarín nappe, the vicinity of Ráztočno, the Tlstá fold in the Veľká Fatra Mts., Podhradie in the Považský Inovec Mts. may be mentioned).

Another factor may be reheating in proximity of neovolcanics (e.g., Hronicum unit in so-called Levice "islands" with CAI 4.0–5.0).

A better tectonic correlation of the isolated Hronic nappe piles and a reevaluation of the current ideas about that question is an important task for the future which needs a greater CAI-data set as available in the moment.

2) Muráň nappe and Stratená nappe

Both units, which have to be separated from the Gemericum underneath (MELLO, 1979), presently interpreted as a part of the Silicicum, show facial affinities to parts of the Juvavic Mürzalpen nappe in the NCA (BYSTRICKY, 1982). However, in contrast to the Silicicum s. str. in the region of the Slovak karst, the sedimentary sequences of the Muráň- and Stratená nappe show a high thermal alteration (CAI 5.5–6.0). Same CAI values occur in the main body of the Mürzalpen (CAI 5.5–6.0) and Schneeberg nappe (CAI 4.0–5.0). Similar high CAI-values can be recognized in outliers of the Stratená nappe in the Galmus mountains and in their southeastern continuation near Košice (CAI 5.5–6.0).

3) Silicicum s. str. (Slovak karst)

The Mesozoic of the Slovak karst (= Silicicum s. str.), first regarded as a rootless nappe which has to be seperated from the Paleozoic below by KOZUR & MOCK (1973).

The CAI values indicate that the situation is complicated, CAI values are varying from1.0–5.5 (though CAI-values 1.0–1.5–2.0 prevail). Either there are more tectonic units or CAI values increase in one tectonic unit for similar or also further causes as are mentioned in the Hronicum.

According to MELLO et al. (1996) and LEXA et al. (2000) (e.g., Section on the Geological maps of the Western Carpathians) the Silicicum is underlain by the Turnaicum and Meliaticum.
To the south the silicicum of the Slovak karst is bounded by the Derenk unit with very low CAI-values (CAI 1.0). So CAI values show a complex tectonic style of the Silicicum s. str. and a herterogenous nappe complex.

4) The **Turnaicum**, which is exposed in a window in the Turna valley and in the northwestern foreland of the Slovak karst is affected by a strong thermal alteration (CAI 5.5–8.0).

5) Krížna nappe

According to LEXA et al. (2000) the Krížna nappe is denoted as equivalent of the Frankenfels- and Lunz nappe in the NCA. For tectonic and mainly facial reasons (Carpathian Keuper) the Krížna nappe was interpreted as an homologous counterpart of the Lower Austroalpine Semmering unit (ANDRUSOV, 1968:88; TOLLMANN, 1986:73, Tab. 2). The latter is in good accordance with the high CAI-values in the Krížna nappe (CAI 5.5–6.0) and in the Semmering unit (CAI 6.0–7.0).

We present examples from units with:

1. strong alteration in the central and eastern part of the Northern Calcareous Alps (e.g., Hochkönig, Mürzalpen unit – CAI 6.0), partly with CAI inversions, and of the Western Carpathians (e.g., Stratená unit),
2. locations in the Northern Calcareous Alps with metamorphic blocks and slides in Upper Jurassic carbonate clastic radiolaritc flysch basins (e.g., Berchtesgaden area, Hallstatt area), called Meliaticum in the Western Carpathians (e.g., Hallstatt slides on top and beside the Stratená unit),
3. areas with backthrusting and imbrication of the CAI-zones with tectonic shortening in the Northern Calcareous Alps (e.g., southern part of the Dachstein block), areas with medium CAI values with south to north and bottom to top decrease in temperature in the Northern Calcareous Alps (e.g. Schneealpen unit, Salzburg and Berchtesgaden area),
4. areas with low alteration in the Western Carpathians (Hronicum nappe system),
5. Sharp CAI boundaries between the units.

Results

- CAI-data of the Bavaric and Tirolic nappes in the NCA and of the Hronicum are in good accordance in respect to the low thermal alteration in both units. Concerning this results and in correspondence with KOVÁČ & HAVRILA (1998) and PLAŠIENKA et al. (1997) it can be strictly excluded that the higher Subtatric nappes could be regarded as counterparts of the Silicicum as it was partly belived in former times.
- The Silicicum of the CWC is a corresponding element of the Juvavic nappe system in the NCA. In the term ”Silicicum” are included sequences of two disconnected regions sharply differing in facies and the degree of thermal alteration. Therefore the term ”Silicicum”

should be restricted to the nappes in the type region of the Slovak karst.

Also the elements of the Juvavic nappe system in the Alps are highly inhomogenous in respect to their former paleogeographic position and their later tectonic history. It should be observed that the term "Juvavic" denotes only a common transport of heterogenous gliding masses onto the foreland during late Jurassic. Therefore a clear terminologic discrimination of the heterogenous elements of this olistolithic melange, called Juvavicum and equivalents, is needed.

- Nappe tectonics of the CWC is probably more complicated than realised till now. CAI-data will help us to discern the regional tectonic position of a single thrust element within a local nappe pile.

In some parts of the Western Carpathians and the Northern Calcareous Alps the CAI-zones are transsected by Miocene lateral tectonic extrusion.

The mapping of CAI zones is an important tool for the reconstruction of the paleogeographic and tectonic configuration in Upper Jurassic and Cretaceous times and helps to understand the present block puzzle of the CWC and the NCA. For example, unknown tectonic boundaries can be localized and "classical" stratigraphic successions can be demonstrated as tectonically imbricated.

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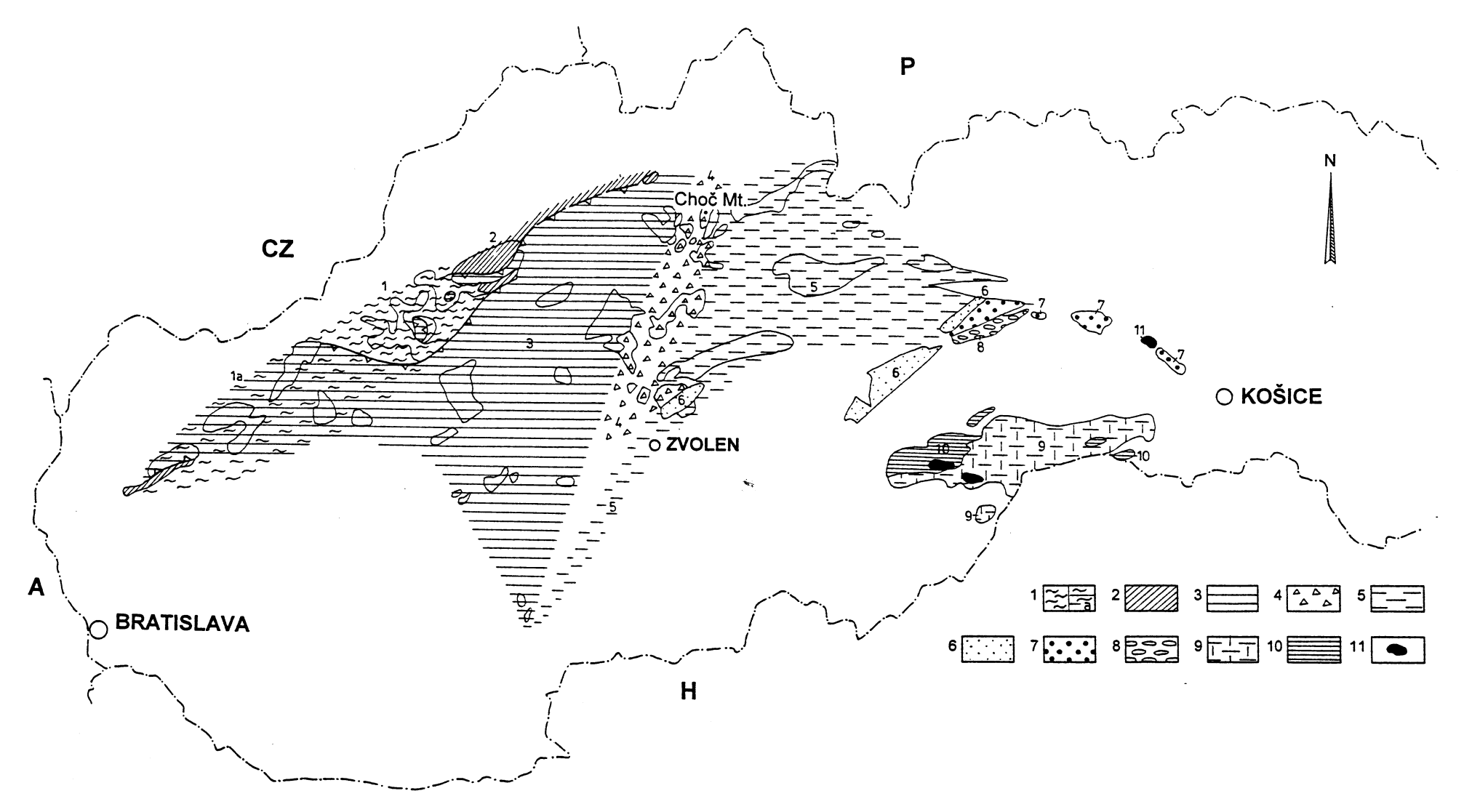
Fig.1: CAI values in units of the Central and Inner West Carpathians
HRONICUM: 1 – Dobrá voda and Homôlka (Rohatá skala) nappe (CAI 1,5–2–2,5), a) covered by the Považie nappe; **2** – Ostrá Malenica (CAI 1–1,5) and Veterník nappe (CAI 1,5–2); **3** – Považie nappe (CAI 1–1,5) (= Havranica, Jablonica, Nedzov, Strážov and Tematín „nappes"); **4** – Šturec nappe (CAI 1–1,5–2); **5** – nappes originated from the Biely Váh facial area (Choč, Svarín, Okošená, Svíbová and Bystrá nappes (CAI 1,5–2, in the south in a narrow zone up to 4, in the Levice „islands" even 4–5); **SILICICUM: 6** – Vernár and Lower Muráň nappes, Drienok nappe (CAI 1,5–2–4); **7** – Glac and Galmus nappes, Murovaná skala nappe (CAI 5–6–8); **8** – Geravy nappe (CAI 1,5–6); **9** – Silica nappe (CAI 1,0–5,5); **TURNAICUM: 10** – Turňa nappe (CAI 5,5–8); **MELIATICUM: 11** – Meliaticum (Jaklovce, CAI 5–8, Slovak karst – no data)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