

Guadalupian Paleobiogeography across the Neotethys Ocean*

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Abstract

The Guadalupian was a period of climate change and plate-tectonic reconfiguration. Climate changed from glacial conditions at the dawn of the Permian to warm global conditions in the Guadalupian. The Cimmerian terranes migrated from southern Gondwanan paleolatitudes in the Early Permian to subequatorial paleolatitudes by the Middle-Late Permian as the result of the opening of the Neotethys Ocean. This opening was asymmetrical, with higher seafloor spreading rates for the central Cimmerian terranes (central Afghanistan, Karakoram) than for the western terranes (Iran), and it took place contemporaneously with the transformation of Pangea from an Irvingian B to a Wegenerian A-type configuration.

During this Early to Middle Permian tectono-climatic transition, bioprovincial patterns evolved rapidly across the southern and northern margins of the opening Neotethys Ocean, making brachiopod paleobiogeography a useful tool to test its complex opening. Guadalupian (Wordian) brachiopod faunas from Sicily, Tunisia, Turkey, Oman, North Iran, Central Afghanistan, Karakorum, Salt Range and South Thailand have been compared by multivariate analysis to test their similarity and pattern of distribution.

The results of cluster analysis and principal coordinate analysis have been placed on an independently derived paleogeographic reconstruction, allowing us to draw the following conclusions:

- (i) Central Afghanistan and Karakorum faced the Paleotethys open ocean and were bathed by a paleoequatorial current that dispersed larvae towards the Tethyan Gulf and the Gondwanan margin.
- (ii) Tunisia and Sicily (Sosio), located in the westernmost Tethyan Gulf, were thus more prone to isolation with respect to Tethyan open-ocean faunas. (iii) North Iran shows affinities to the Perigondwanan regions of Turkey, Oman, and Salt Range being only slightly detached from the Gondwanan margin due to the incipient opening of the Neotethys; a current gyre bathed both the Gondwanan margin and the Iranian block.
- (iii) South Thailand and the Salt Range show affinities to the northern Gondwanan margin.

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Guadalupian paleobiogeography across the Neotethys Ocean

DARIUS
PROGRAMME



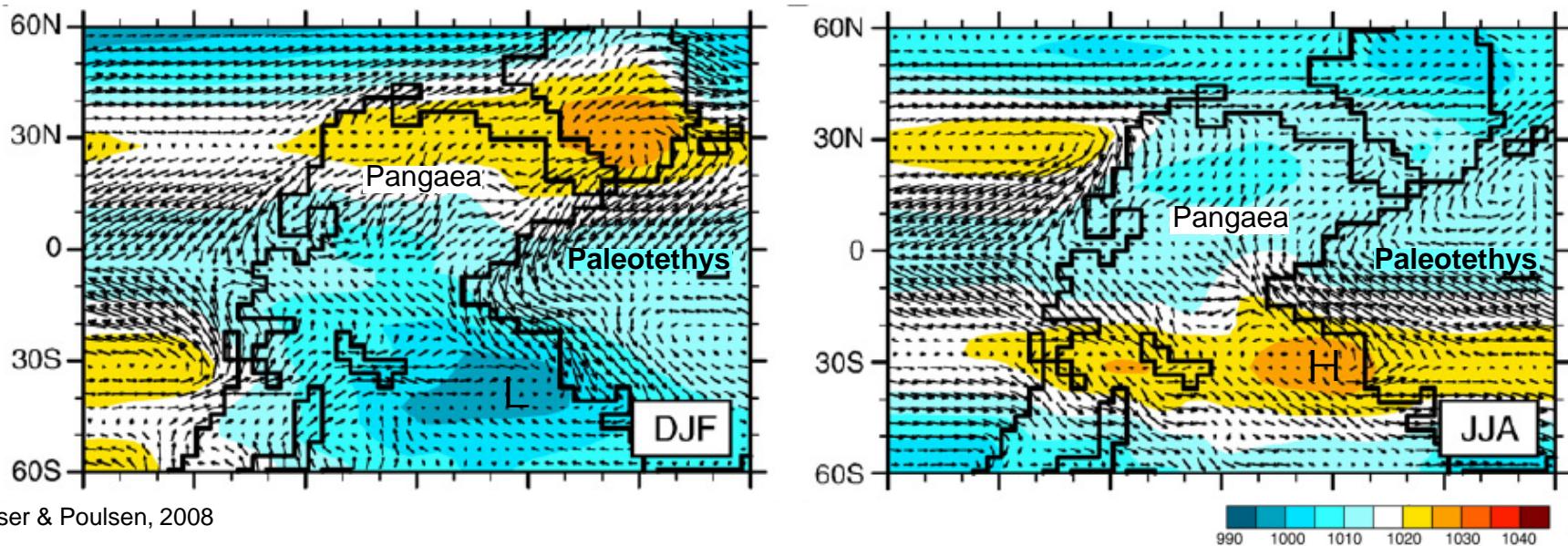
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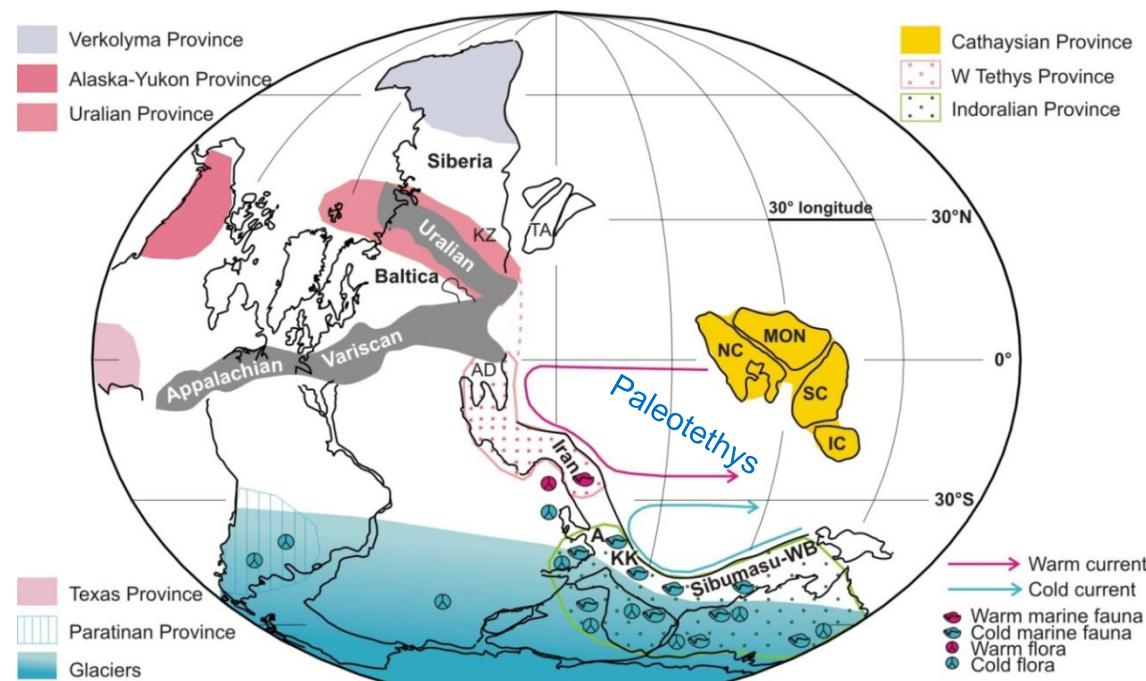
Middle East Basins
Evolution Programme



From glaciation in the Early Permian to monsoons in the Middle Permian



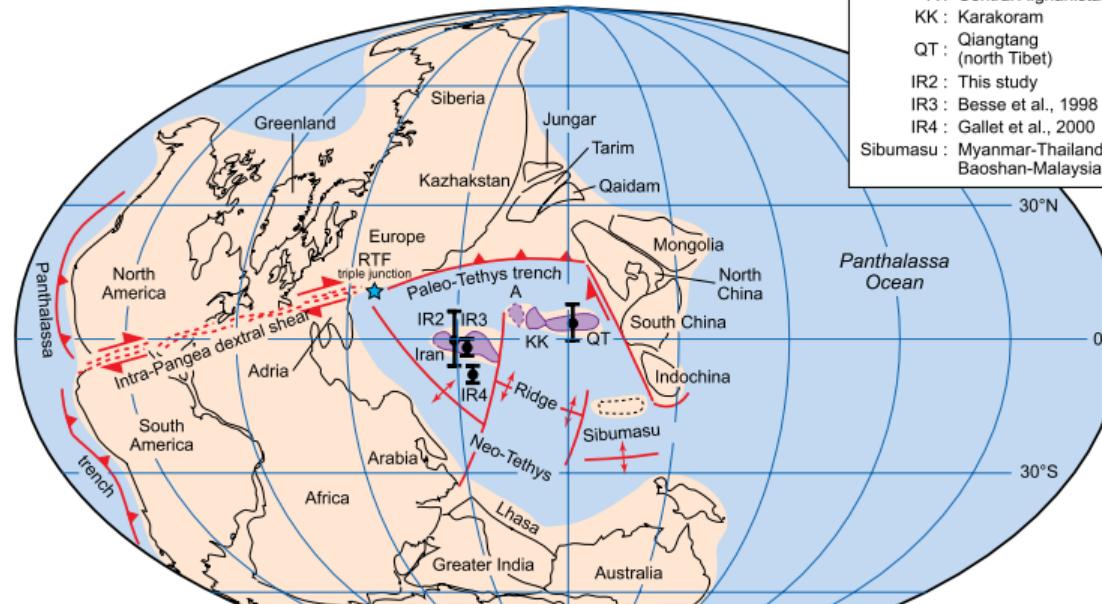
Peyser & Poulsen, 2008



Angiolini et al. 2007

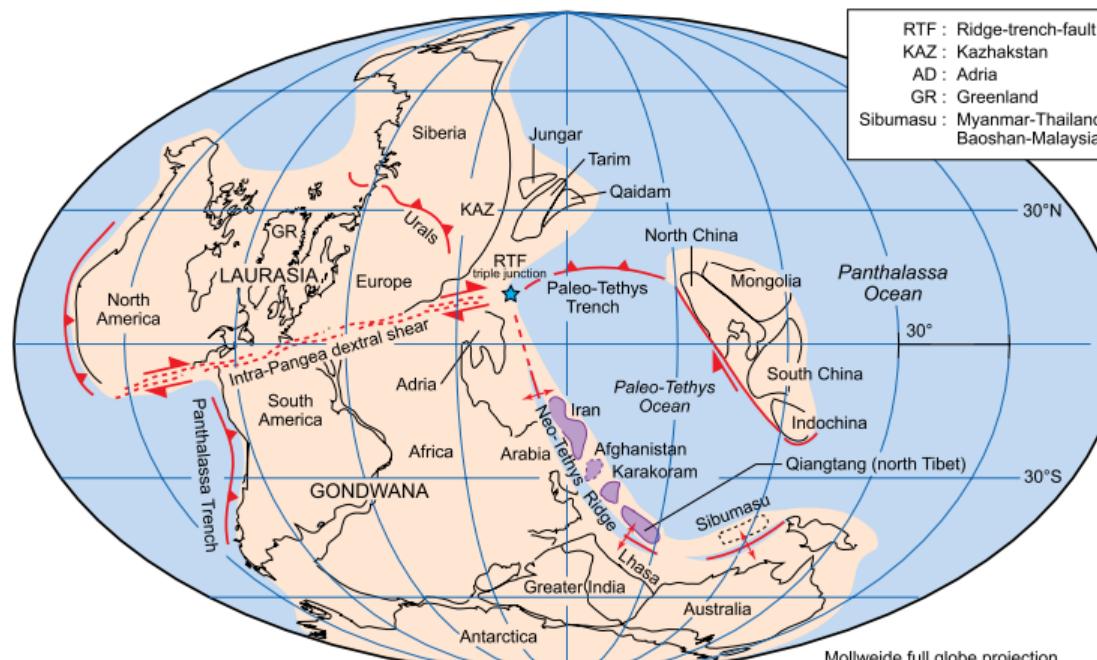
From an Irvingian B configuration to a Wegenerian A configuration

LATE PERMIAN – EARLY TRIASSIC (ca. 260–249 Ma) PANGEA A



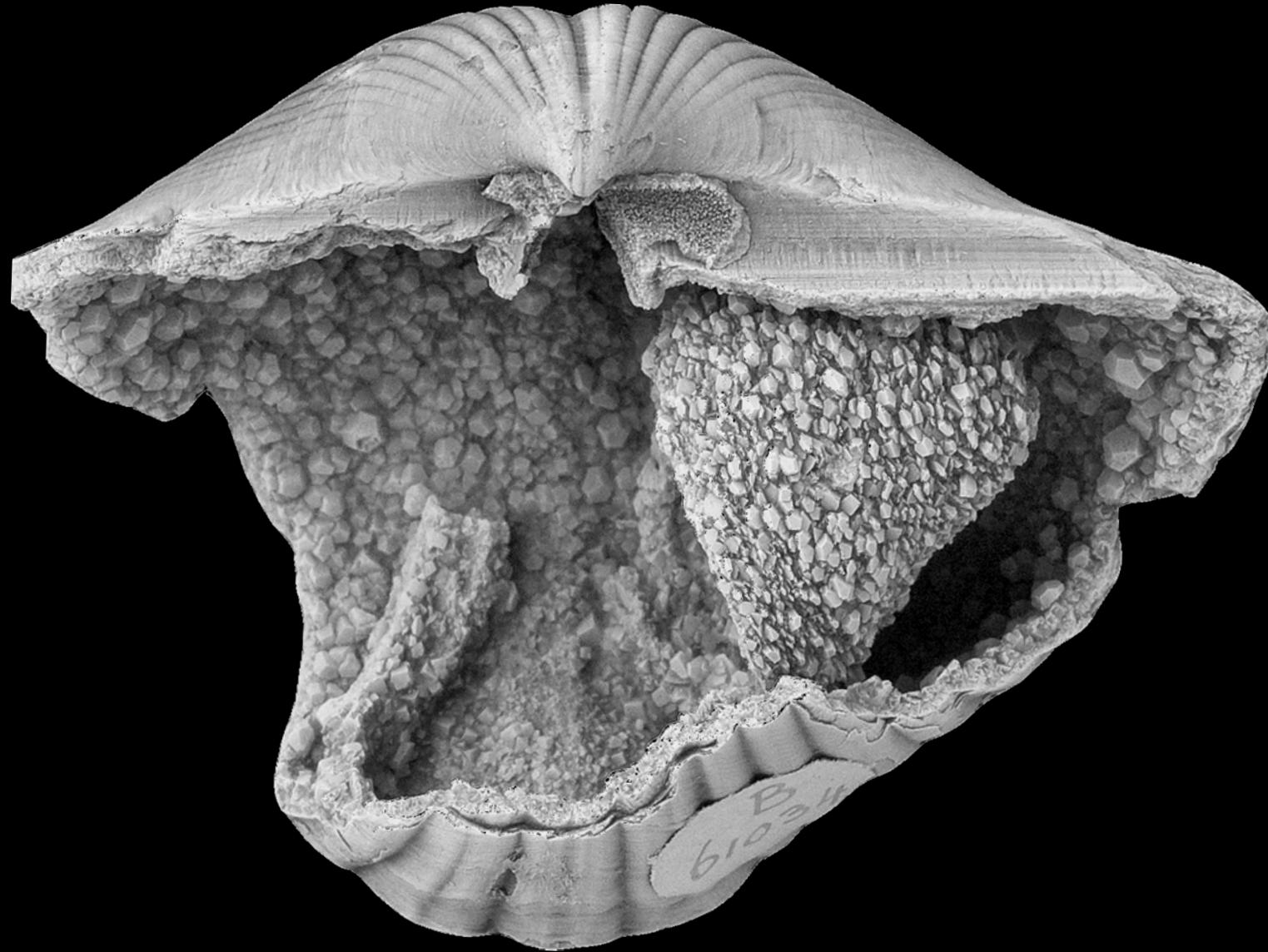
RTF : Ridge-trench-fault
A : Central Afghanistan
KK : Karakoram
QT : (north Tibet)
IR2 : This study
IR3 : Besse et al., 1998
IR4 : Gallet et al., 2000
Sibumasu : Myanmar-Thailand-Baoshan-Malaysia

EARLY PERMIAN (ca. 296–272 Ma) PANGEA B



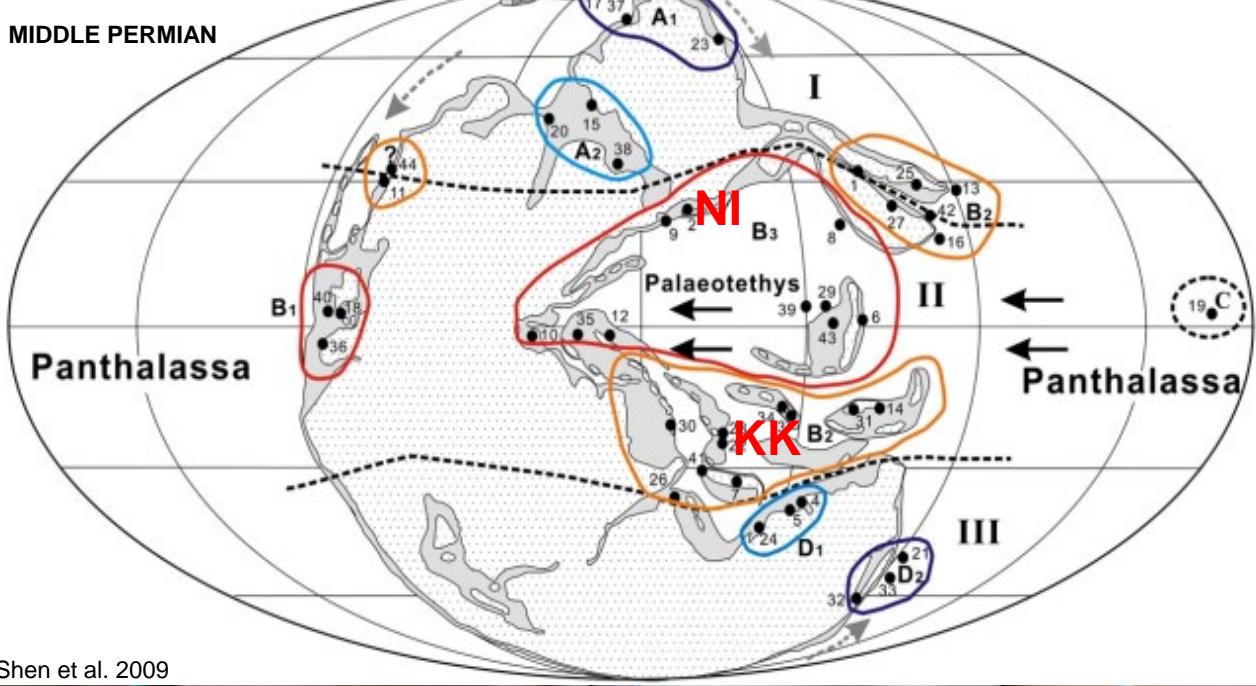
RTF : Ridge-trench-fault
KAZ : Kazakhstan
AD : Adria
GR : Greenland
Sibumasu : Myanmar-Thailand-Baoshan-Malaysia

Brachiopods: good tools for paleobiogeography?



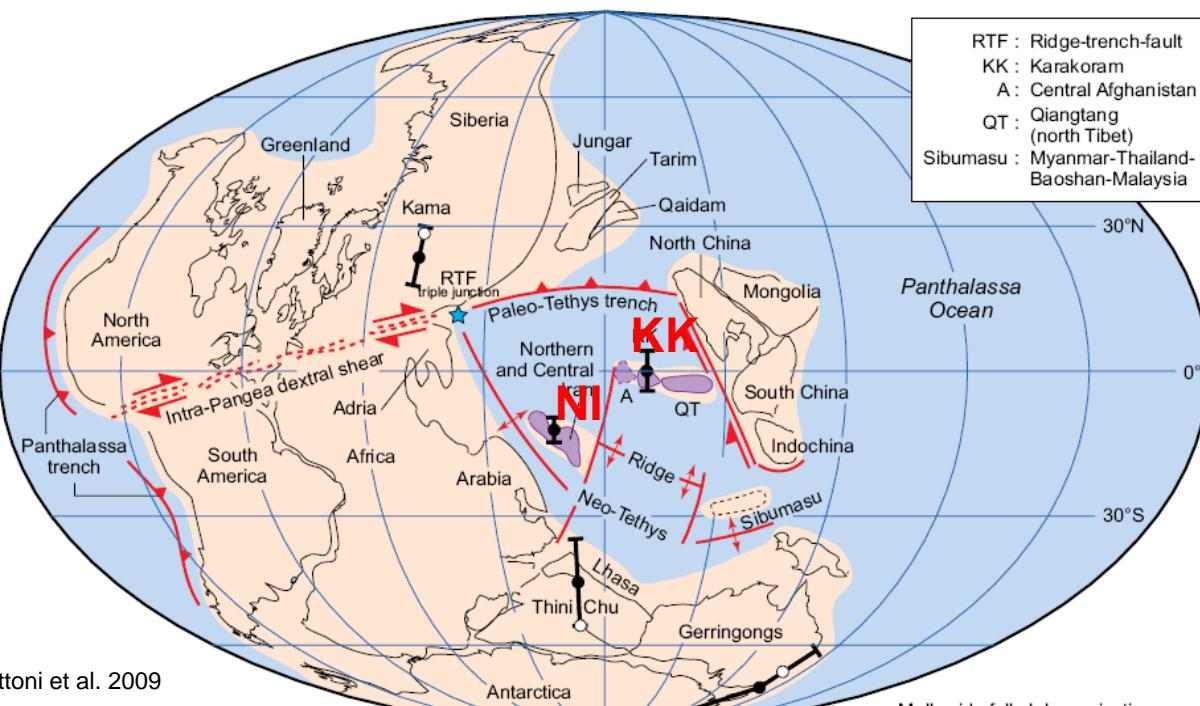


MIDDLE PERMIAN



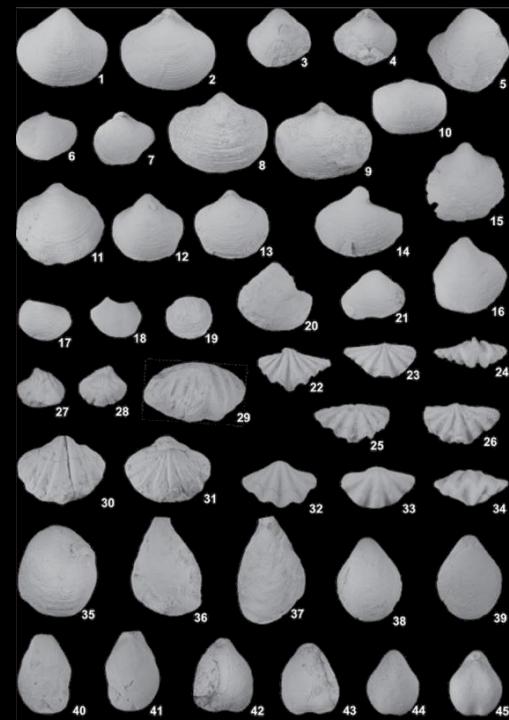
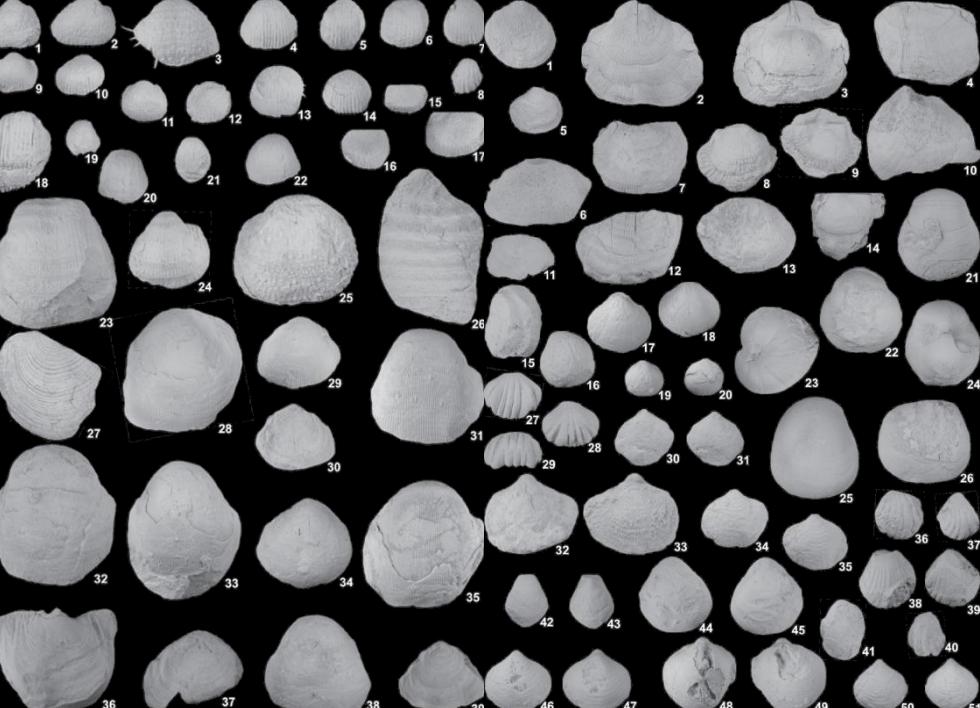
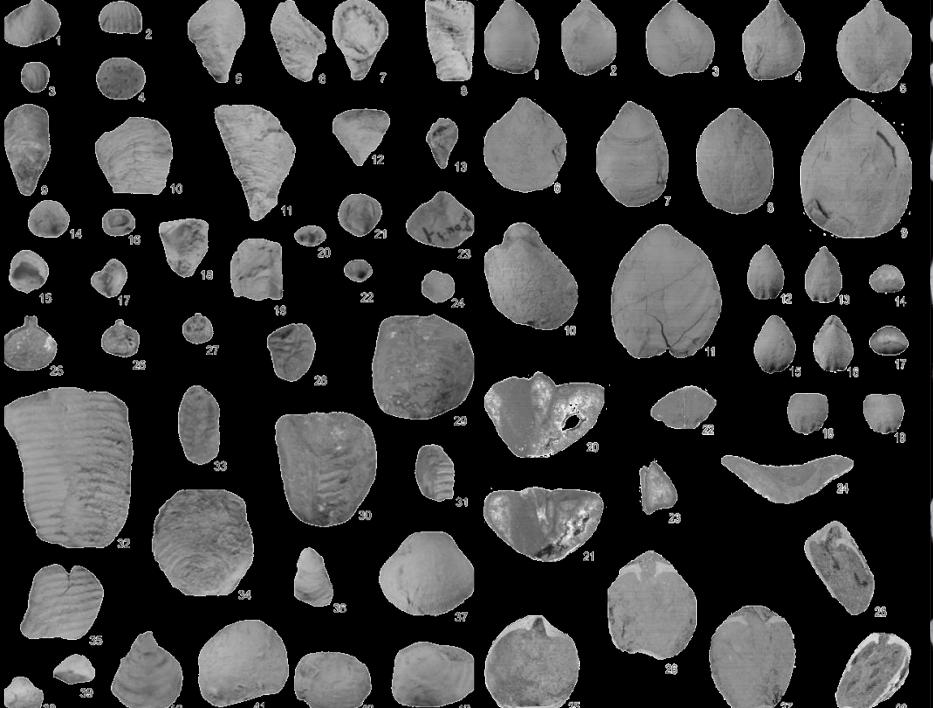
Shen et al. 2009

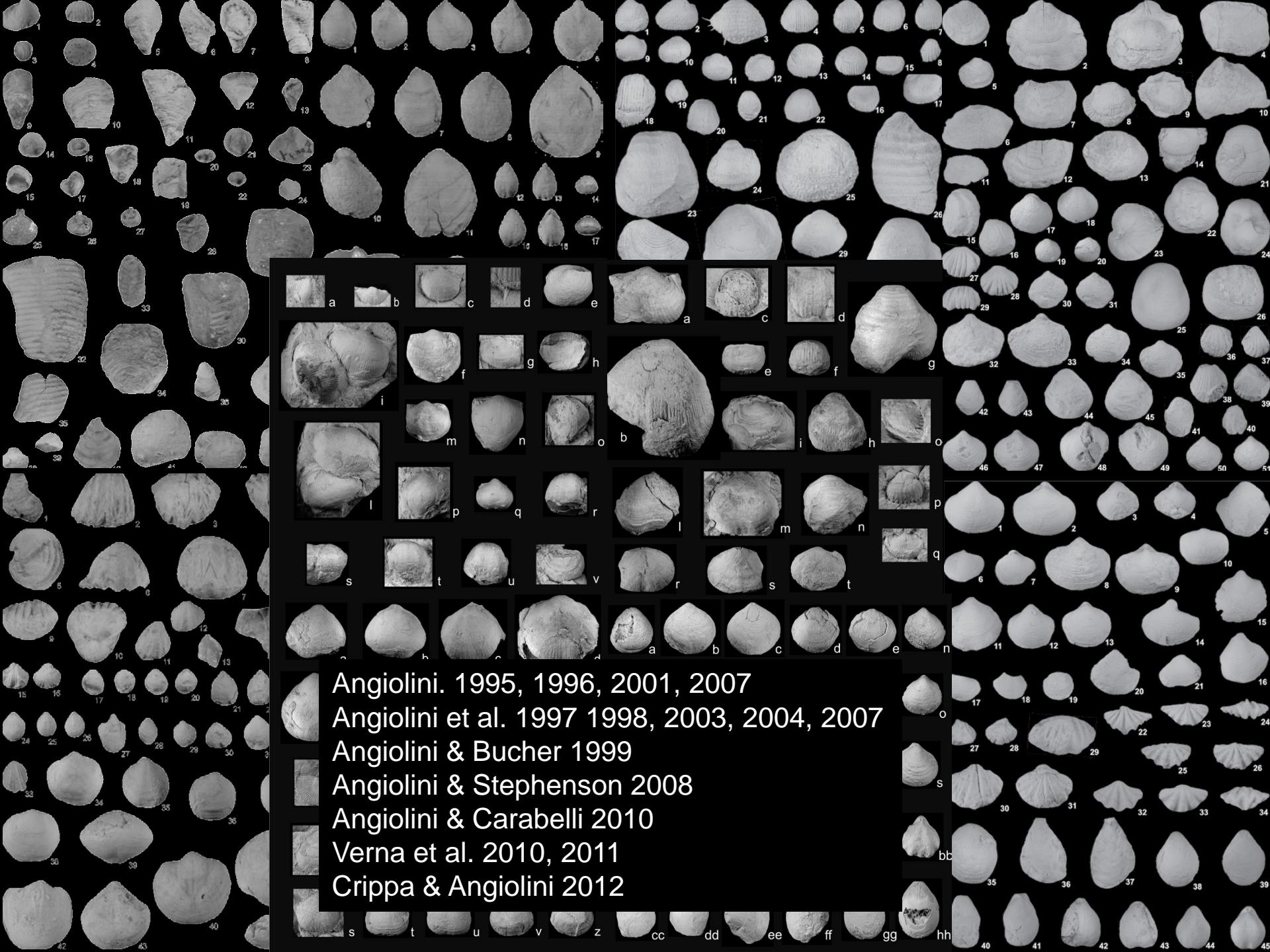
MIDDLE PERMIAN (ca. 272–260 Ma) PANGEA B TRANSFORMING TO PANGEA A



Muttoni et al. 2009







Angiolini. 1995, 1996, 2001, 2007

Angiolini et al. 1997 1998, 2003, 2004, 2007

Angiolini & Bucher 1999

Angiolini & Stephenson 2008

Angiolini & Carabelli 2010

Verna et al. 2010, 2011

Crippa & Angiolini 2012

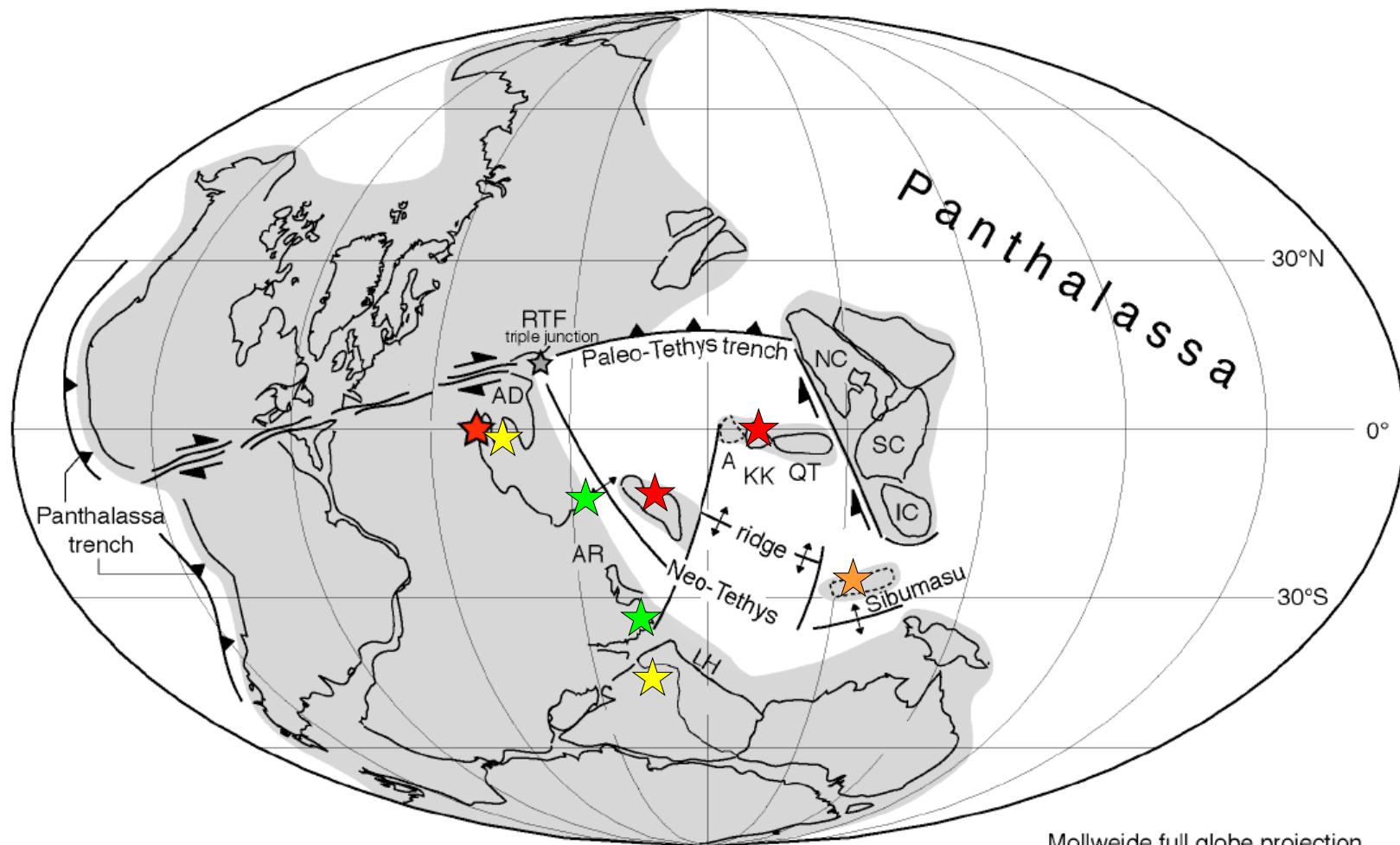
s t u v z cc dd ee ff gg hh

Middle Permian Paleolatitude Tunis: $-1^\circ \pm 2^\circ$

Middle Permian Paleolatitude Alborz: $-12^\circ \pm 2^\circ$

Middle Permian Paleolatitude Karakorum: $0^\circ \pm 1^\circ$

Middle Permian (~272–260 Ma)



Paleolatitude	Tunisia ~ 1°S	Sosio ~ 1°S	Turkey ~ 15°S	Oman 20°-30°S	N Iran 12°S	Afghanistan ~ 0°	Karakorum ~ 0°	Salt Range 37° S	Thailand ? 25-30°S
Genera	19	24	30	47	27	37	38	37	75
Permian Ratio									
PR (Stehli 1970)	PR 1.43	PR 2.0	PR 1.22	PR 1.0	PR 0.35	PR 0.77	PR 0.71	PR 1.00	PR 1.40
PR (em. Shi & Archbold 1996)	PR 0.62	PR 0.87	PR 0.69	PR 0.94	PR 0.31	PR 0.62	PR 0.62	PR 0.87	PR 1.31
Sampling efficiency									
(Stehli & Grant 1971)	SE 43%	SE 43%	SE 56%	SE 94%	SE 87%	SE 81%	SE 87%	SE 87%	SE 94%

Data matrix of 134 brachiopod genera for 9 faunal stations



Masking of the original data matrix

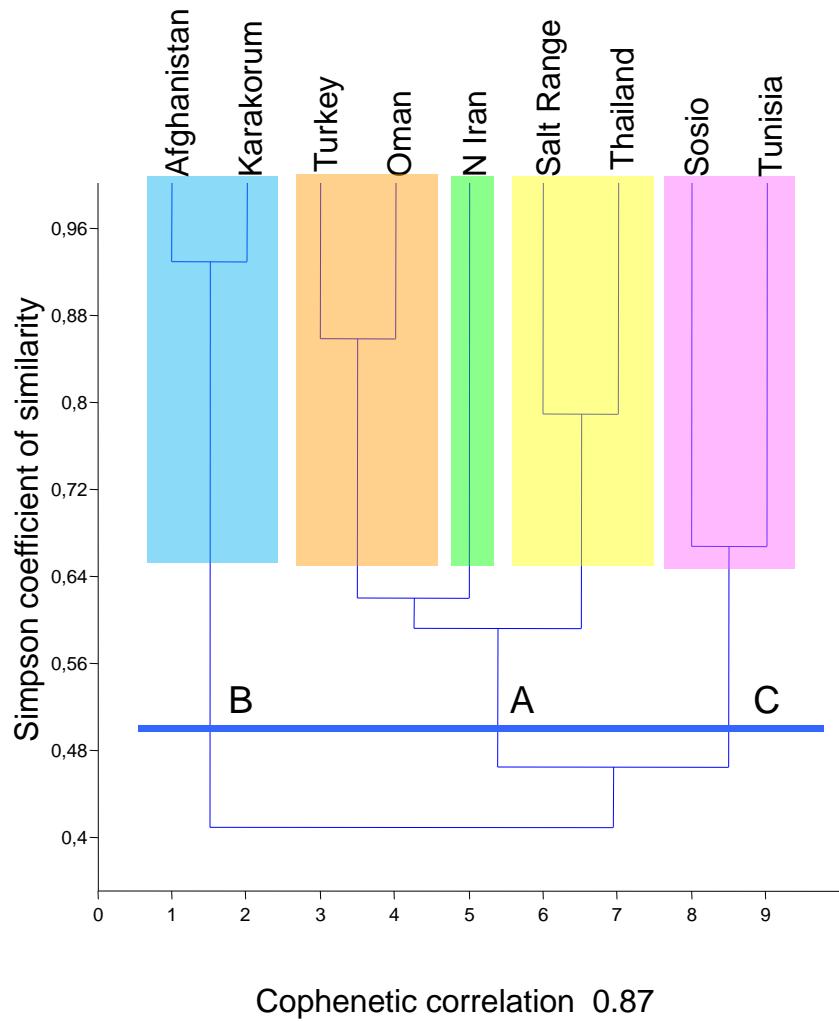
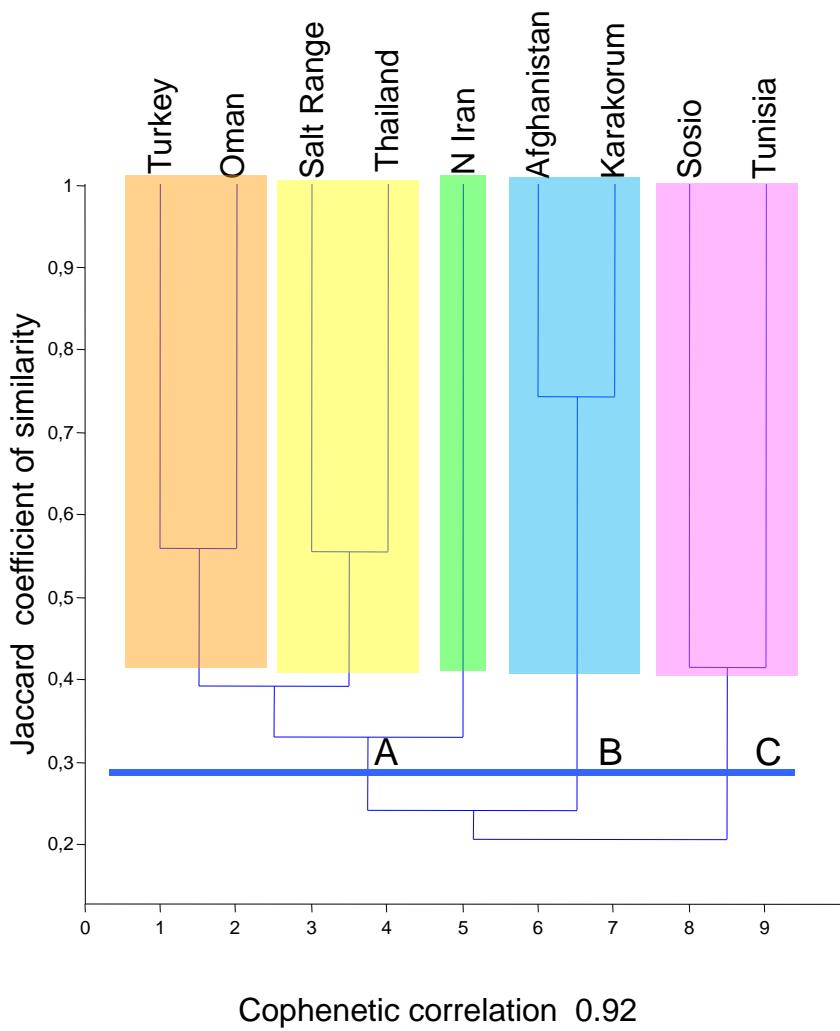


STATISTICAL ANALYSIS (PAST, Hammer et al. 2001)

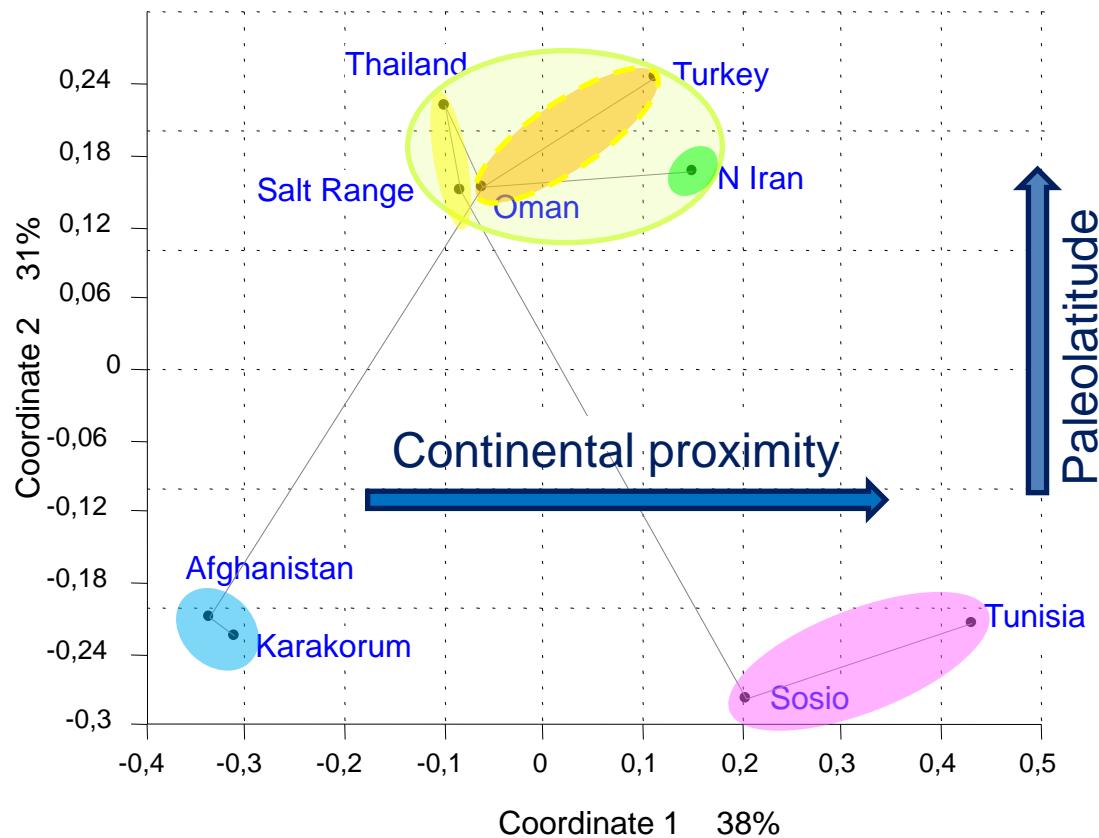
CA

PCO

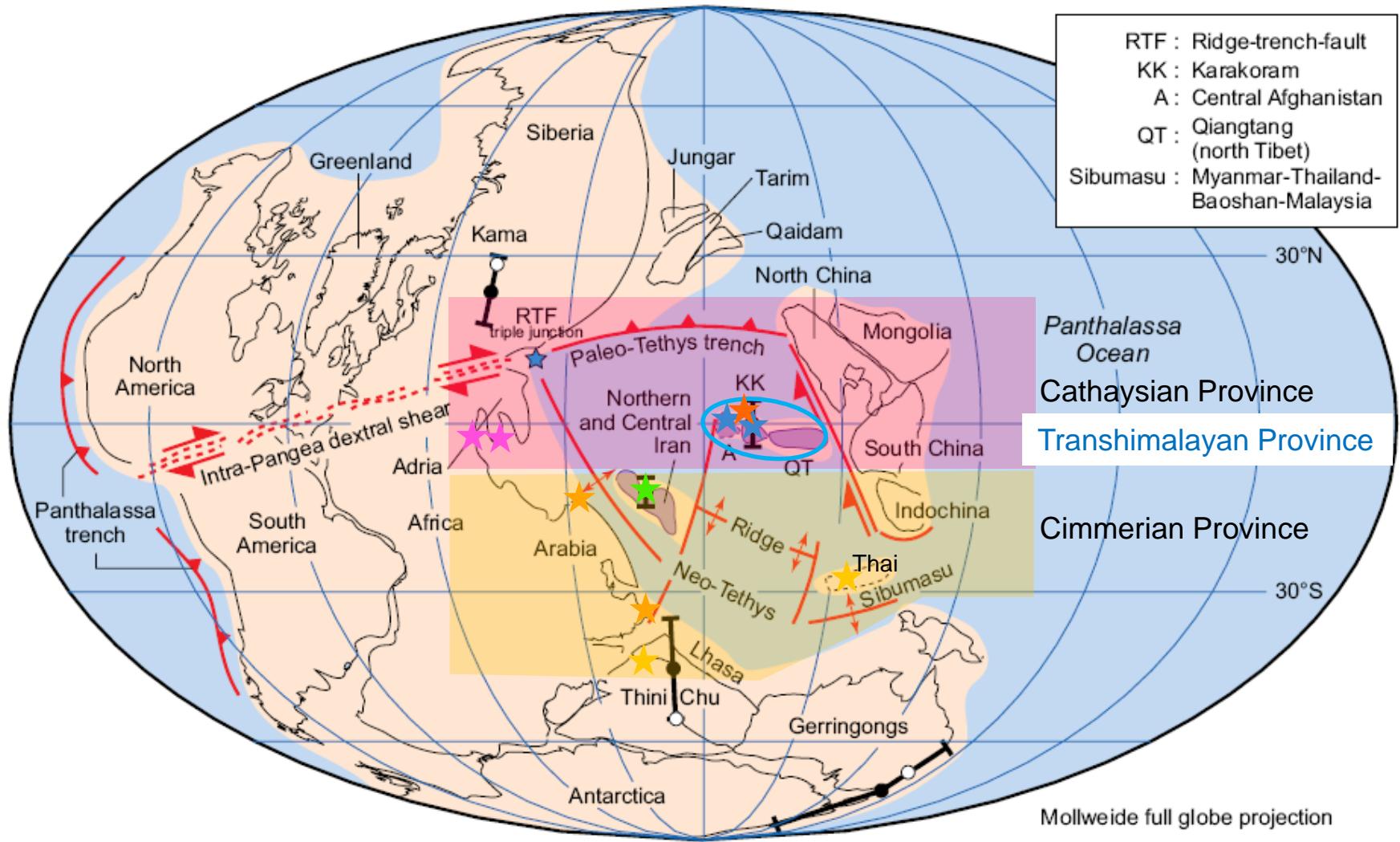
Middle Permian Cluster analysis

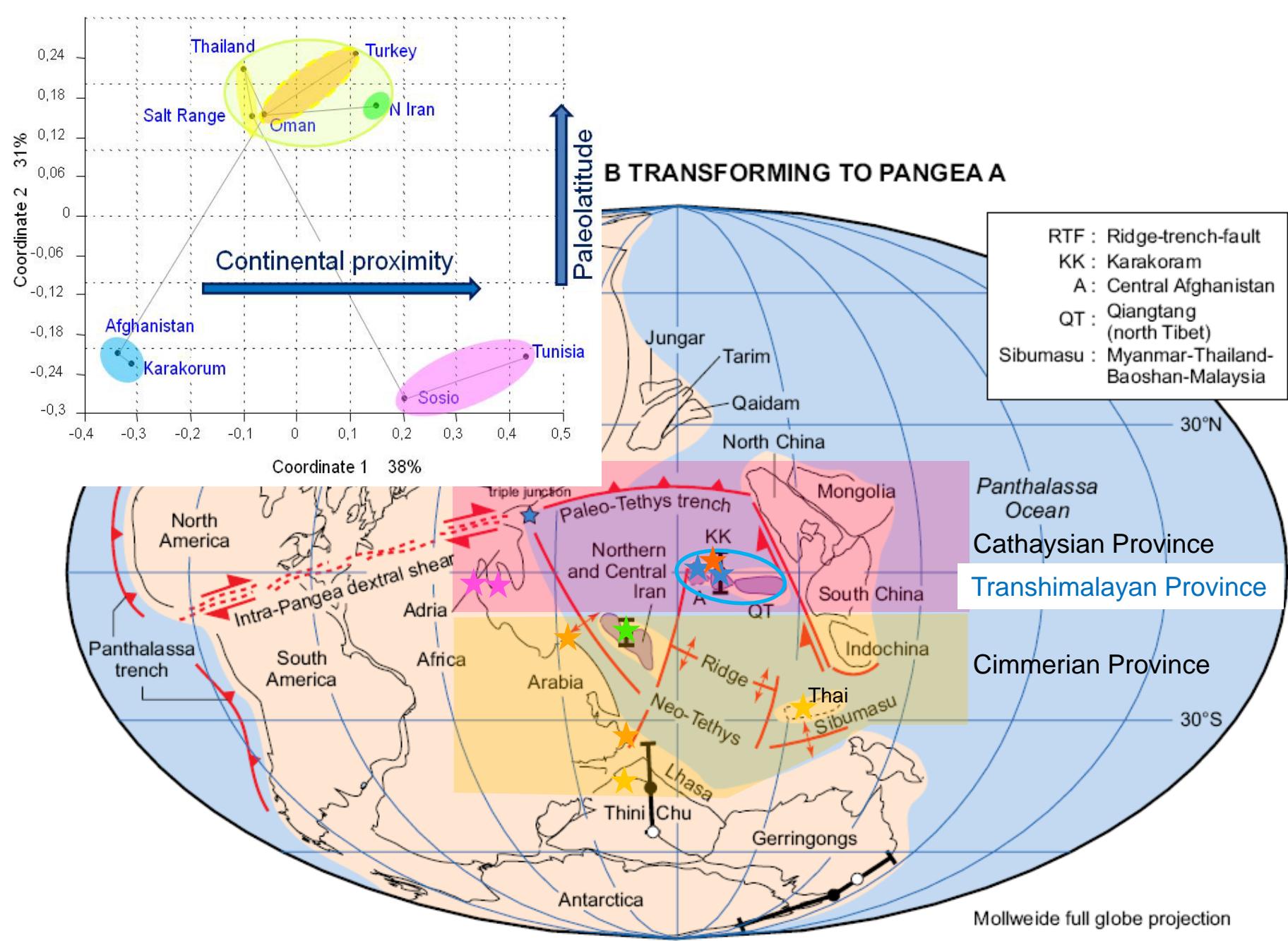


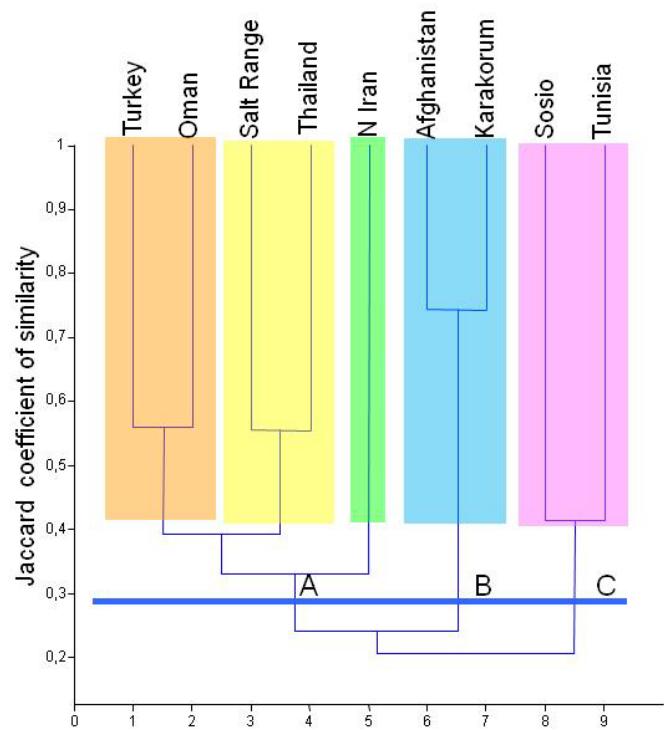
Middle Permian PCO Jaccard



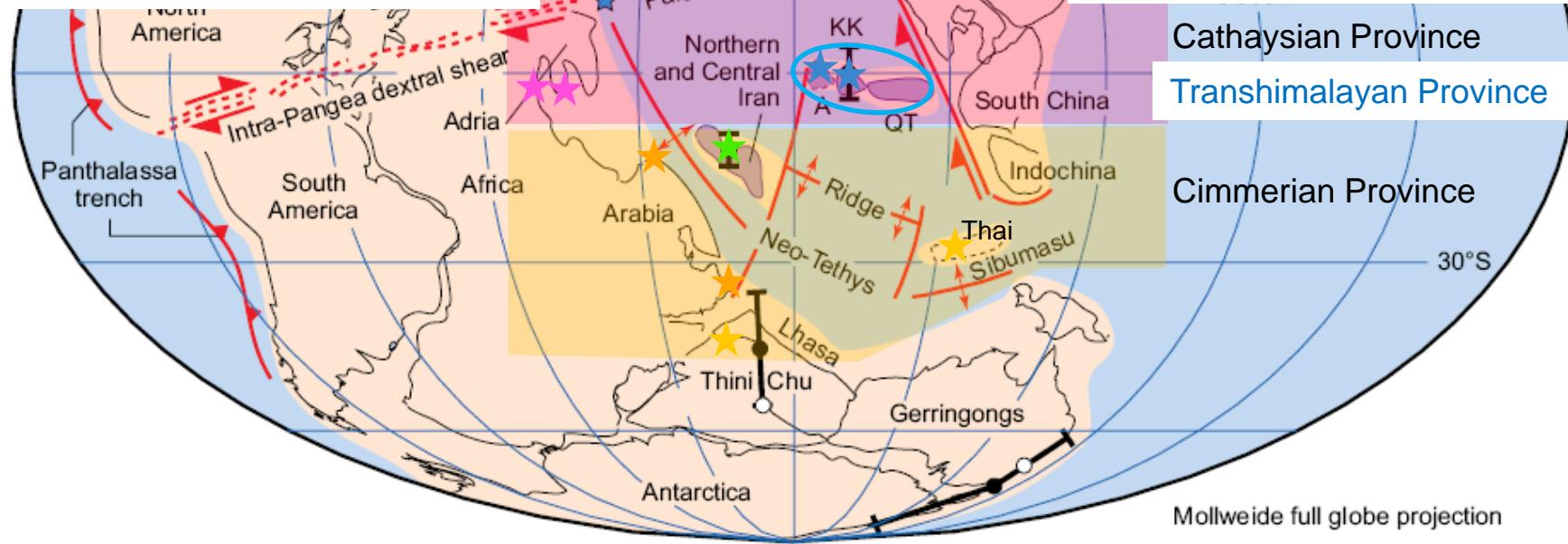
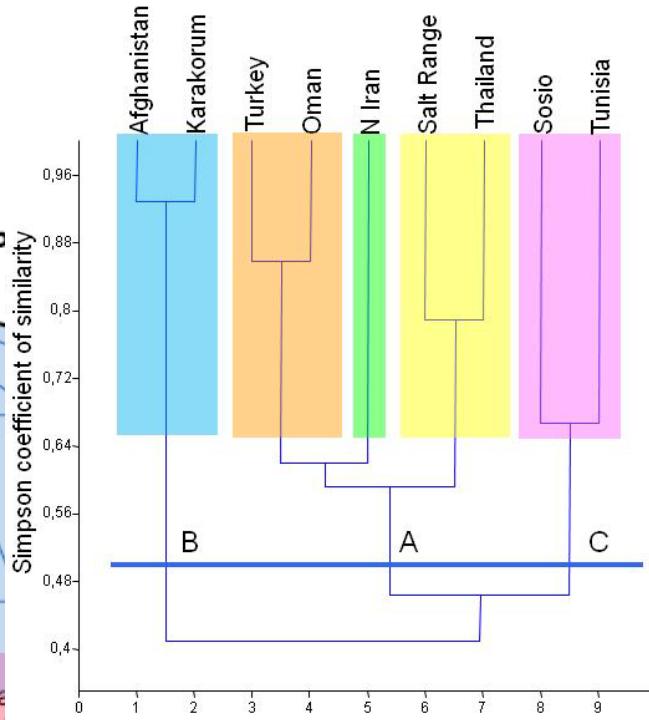
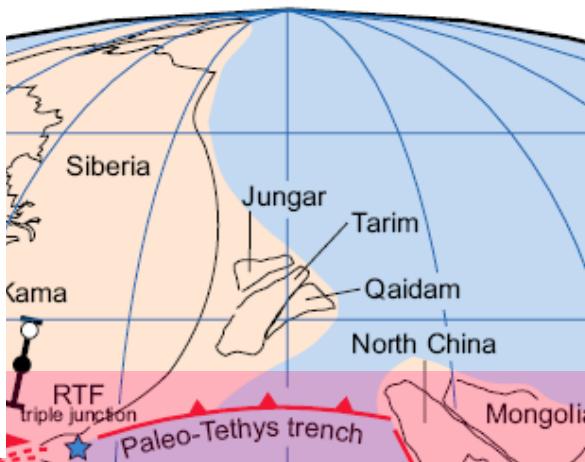
MIDDLE PERMIAN (ca. 272–260 Ma) PANGEA B TRANSFORMING TO PANGEA A



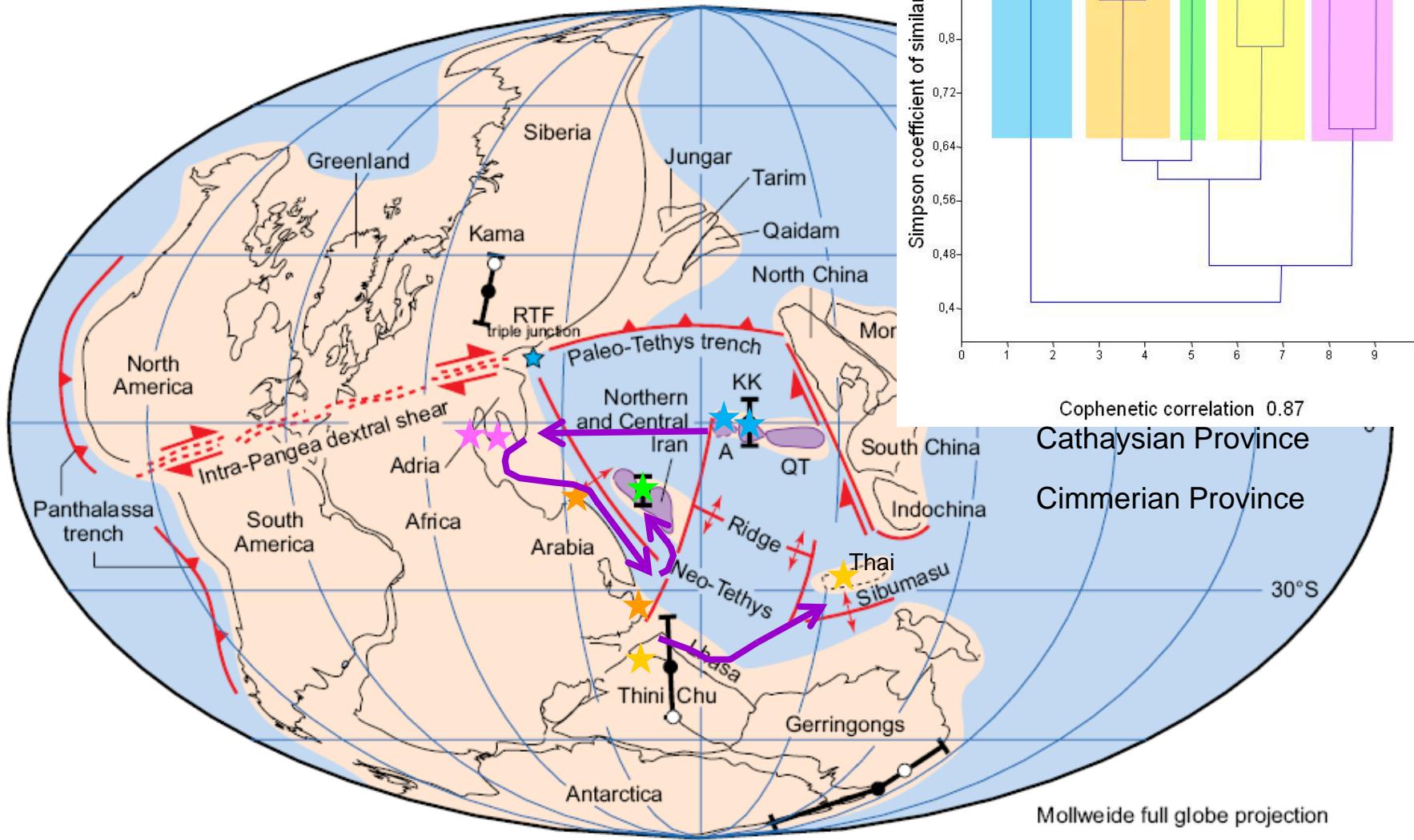




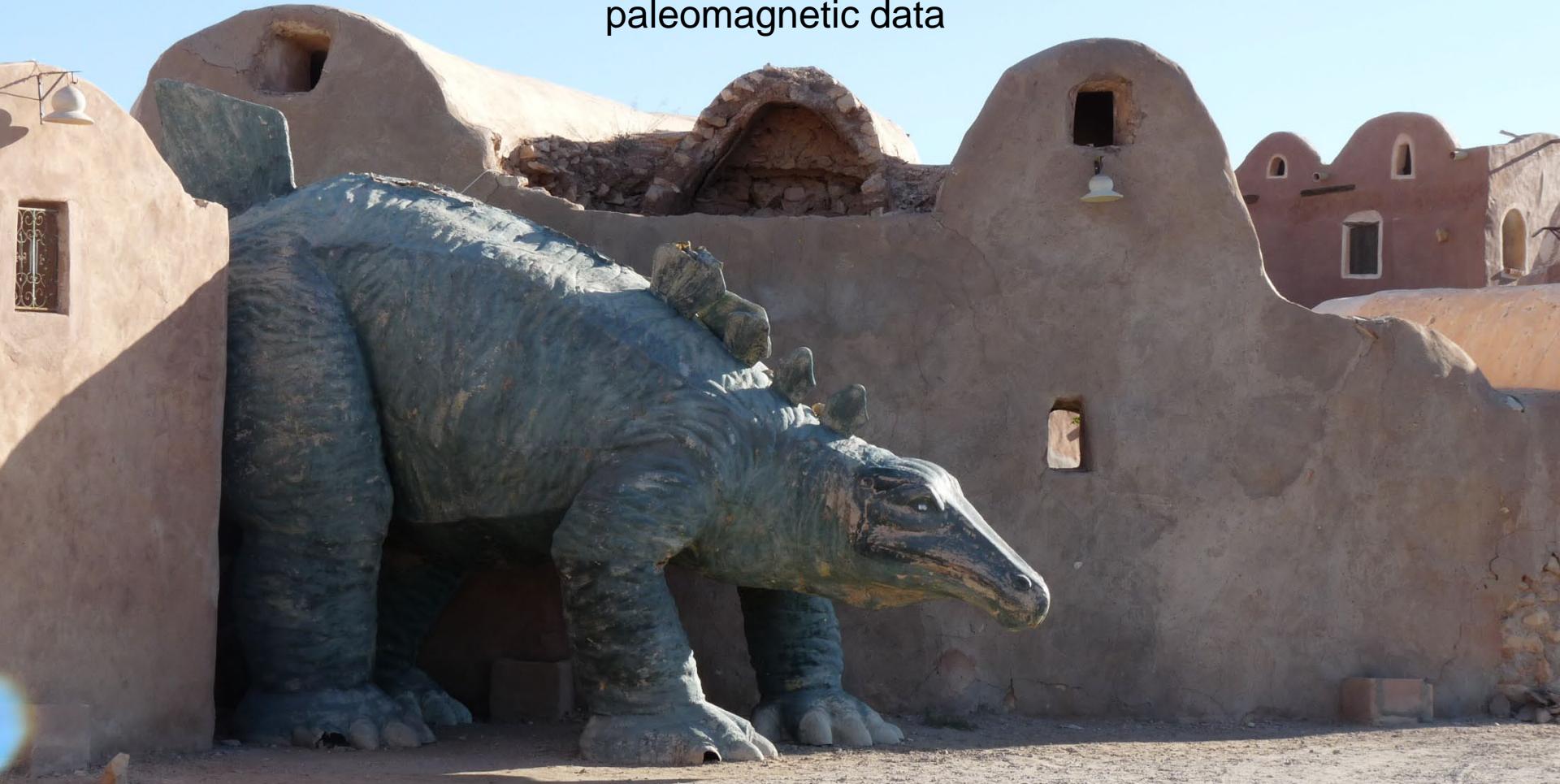
PANGEA B TRANSFORMING TO P



MIDDLE PERMIAN (ca. 272–260 Ma) PANGEA B TRANSFORMING TO PANGEA C



Reliable paleobiogeographic patterns can be obtained only by placing biotic associations on paleogeographic reconstructions constrained by paleomagnetic data



Reliable paleobiogeographic patterns can be obtained only by placing biotic associations on paleogeographic reconstructions constrained by paleomagnetic data

Guadalupian brachiopod distribution supports the asymmetrical opening of the Neotethys envisaged by paleomagnetic-based reconstructions

Central Afghanistan and Karakorum faced the Paleotethys
Tunisia and Sosio were isolated in the westernmost Tehyan Gulf
N Iran shows affinities with the Perigondwanan regions
S Thailand and the Salt Range shows affinities with northern Gondwanan