Cambrian Phosphorites as an archive of the bio-geochemical evolution during the Cambrian Explosion -A coupled isotope investigation-

J. A. Stammeier [1*], D. Hippler [1], O. Nebel[2], A. Leis[3], M. Dietzel [1]

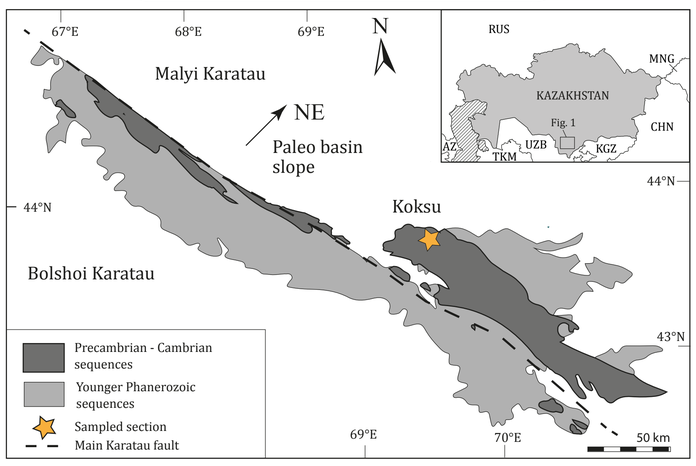
[1] Institute of Applied Geosciences, Graz University of Technology, Austria
*Corresponding author: j.stammeier@tugraz.at
[2] SEAE, Monash University, VIC 3800 Clayton, Australia
[3] JR-AquaConSol GmbH, Joanneum Research, Steyrergasse 21, 8010 Graz, Austria

Precambrian-Cambrian boundary

The Precambrian-Cambrian (PC-C) boundary has been earlier characterized by geological and geochemical means for its environmental and evolutionary changes unique in Earth´s history:

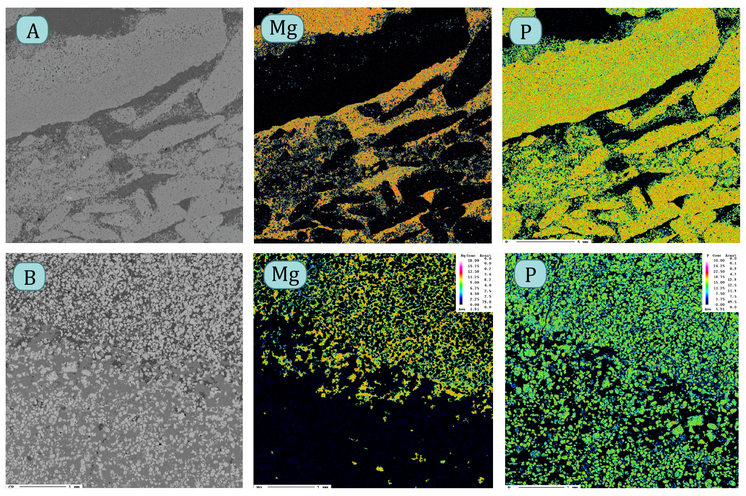
- breakup of supercontinent & re-assemblage
- sea-level changes
- athmospheric & oceanic O_2 increase
- ocean chemistry & circulation (e.g. pH, redox-conditions, Ca availability, salinity)
- perturbations in nutrient cycling
- invention of bioturbation & onset of biomineralization
- "Cambrian Explosion"

Study Area



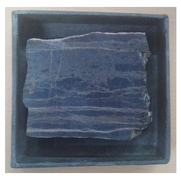
The study section in southern Kazakhstan comprises a continuous record (ca. 50m) of shallow water sediments.

Sample description



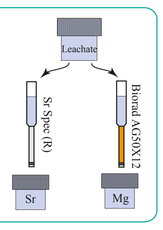
A: Flat-pebble phos conglomerate; B: Phos-grainstone. Microprobe images show Mg is mainly incorporated within the dolomite matrix ($(Mg_{0.43}Ca_{0.61})CO_3$). Other abundant minerals are: Carbonate Fluorapatite ($Ca_{4.9}(P_{2.8}S_{0.05}O_4)_{2.85}(CO_3)_{0.15}F_{0.94}$), calcite ($(Ca_{2.98}Mg_{0.03})CO_3$), quartz ($SiO_2$). Variable textures reflect the changing depositional energies and influences of bioturbation.

Methods



Sample crushing and leaching in 3 M HNO_3 at 70°C for 24 hours to capture both phosphate and carbonate phases.

Chemical purification of the acid soluble fraction (3 M HNO_3 leaching acid).
Mg: BioRad AG50X12
Sr: Sr-specific extraction resin

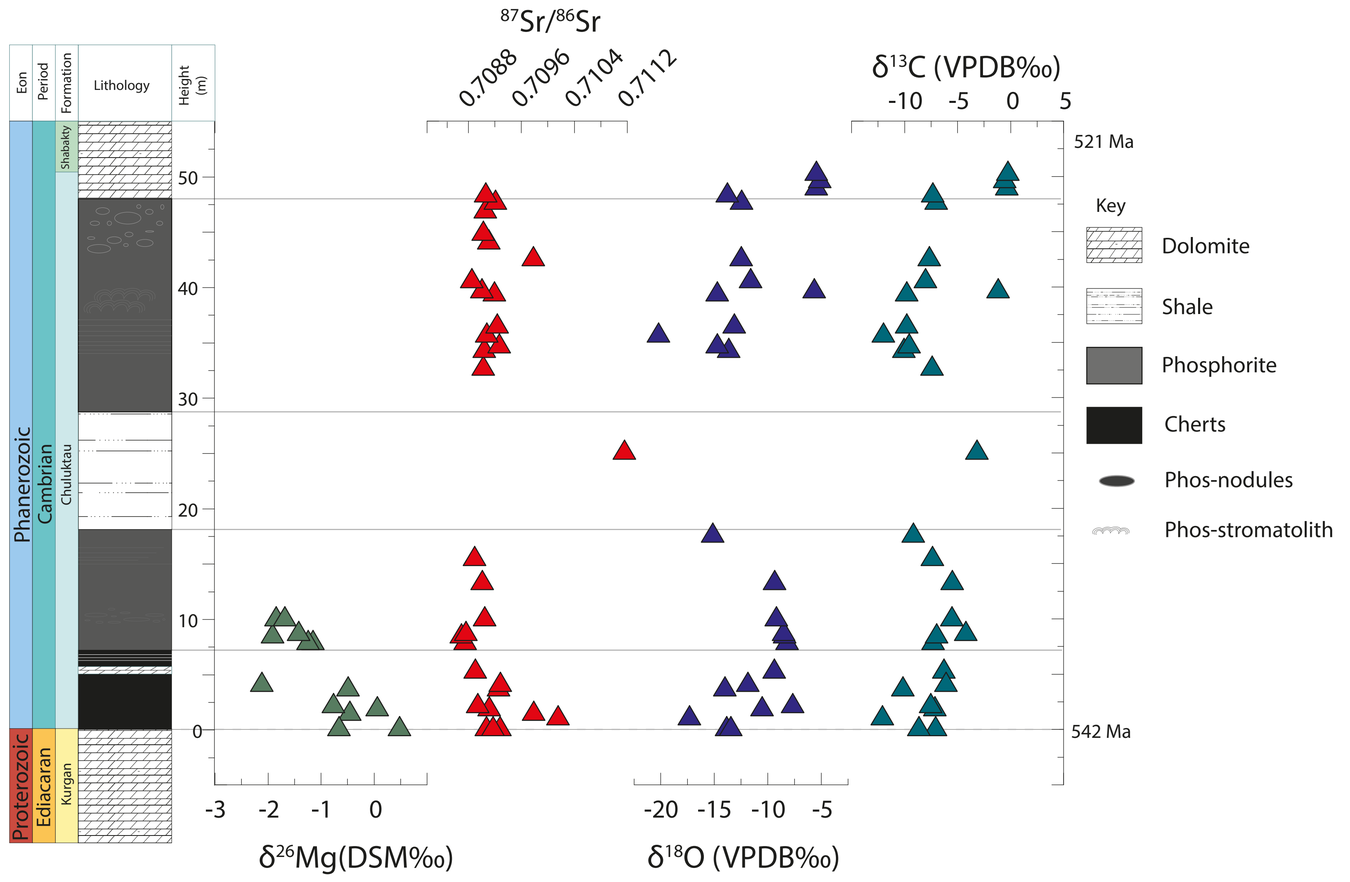


Isotope ratio measurements:
MC-ICP-MS (Nu Plasma II)
Mg: Standard Sample Bracketing (DSM3)
Sr: NIST SRM 987

Acknowledgements

Financial support to DFG-FG 736 and by NAWI Graz is kindly acknowledged .

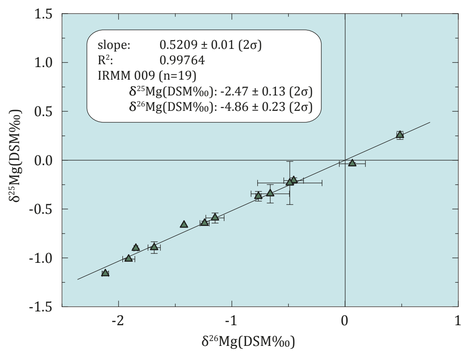
Stratigraphy vs. Isotope distribution



$^{87}Sr/^{86}Sr$ values of Kazakh shallow water successions align with the global Cambrian (ca. 0.7085-0.7090) $^{87}Sr/^{86}Sr$ seawater evolution placing Kazakhstan within an open ocean system.
A negative $\delta^{13}C$ and $\delta^{18}O$ shift can be globally correlated with Cambrian shallow water sediments.

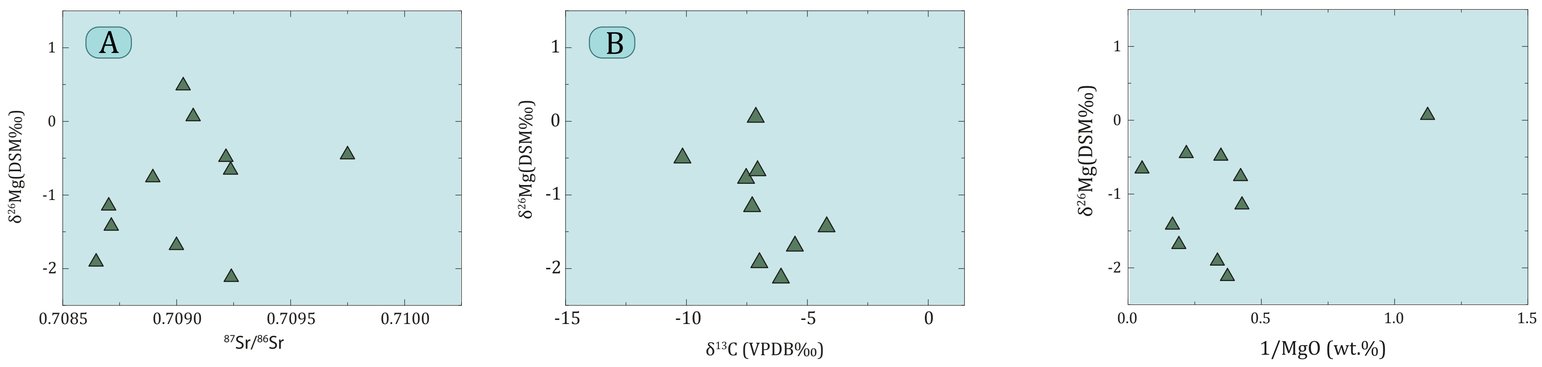
Hypothesis

The innovation of oxydative silicate weathering contributes to already enhanced weathering rates. The increased input and perturbations to the marine nutrient cycle promoted the development of new niches, ultimately driving the "*Cambrian Explosion*" .



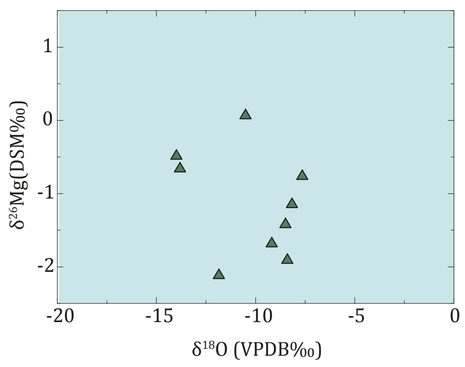
Three isotope plot of measured $\delta^{25}Mg$ vs. $\delta^{26}Mg$. The calculated slope is close to theroretical values of mass- dependen fractionation of Mg isotopes at equilibrium conditions.

Discussion



Experimental studies have shown that dolomite precipitation can be estimated to accounts for $\Delta^{26/24}Mg_{Dolomite\text{-}seawater}$ ~-1.7 to -2.7‰[1]. Consequently, compared to modern seawater values of $\delta^{26}Mg$~ -0.80‰[2], primary Cambrian seawater seems to be enriched in ^{26}Mg with values of approximately -0.5 to +2‰.

High (positive) $\delta^{26}Mg$ values are gained from silicate dominated continental weathering[1] and likely caused the isotopically heavy Mg values at and prior to the Pc-C transition. However, among the available data, a correlation with $^{87}Sr/^{86}Sr$ is only vaguely indicated (A). Instead, a negative correlation between $\delta^{26}Mg$ and $\delta^{13}C$ (B) indicates weathering of exposed carbonate platforms contributed to the Mg pool during the early Cambrian period[2] (B).



A change of weathering regime, to a silicate dominated one, prior to the Pc-C transition lead to increased nutrient input and the development of new nutrient cycles. This in turn could have significantly contributed to the "*Cambrain explosion*".

References

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