

Geochemical Evidence of Biotic Influence in Brazilian Pre-Salt Carbonates*

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Abstract

The Cretaceous pre-salt lacustrine carbonates in the Santos Basin, offshore Brazil, are as geologically enigmatic as they are economically valuable. Much debate has centered lately on the extent to which microbes may have played a role in their genesis. In marine carbonates, biotic and abiotic calcites can be distinguished based on their isotopic and elemental compositions. In this study, we applied these geochemical tests to thin sections and bulk core samples from well BM-S-22 Guarani-1ST (3-ESSO-004-SPS). Modern calcite-producing taxa often show positive linear covariance in carbon and oxygen isotope compositions. These trends are anchored on the most positive end at abiotic carbonate compositions and extend to more negative values in those carbonates precipitated faster. The Guarani samples analyzed in this study show less variation in carbon and oxygen isotope values than many modern calcifiers (like echinoderms, corals, algae), though the range is somewhat consistent with others (like foraminifera). Modern calcite-producing taxa show enrichment in Sr over modern calcite cements as shown on a plot of Mg/Ca vs Sr/Ca. The Guarani samples show this same linear covariance between Mg/Ca and Sr/Ca as well as Sr enrichment, suggesting a biotic influence on their precipitation. These isotopic and elemental data, along with scanning electron microscope images showing fossilized microbes, seem to be undeniable evidence that biological processes played at least some role in the origin of Brazilian pre-salt lacustrine carbonates.

Selected References

Carpenter, S.J., and K.C. Lohmann, 1992, Sr/Mg ratios of modern marine calcite: Empirical indicators of ocean chemistry and precipitation rate: *Geochimica et Cosmochimica Acta*, v. 56, p. 1837-1949.

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Funding

ExxonMobil

Samples



anp
Agência Nacional
do Petróleo,
Gás Natural e Biocombustíveis

Summary: Tested microbialites are likely biotic in origin

Carbonate material was analyzed to test for biological origin

- *Location:* Offshore Santos Basin, Brazil
- *Block:* BM-S-22
- *Well:* Guarani-1ST (3-ESSO-004-SPS)

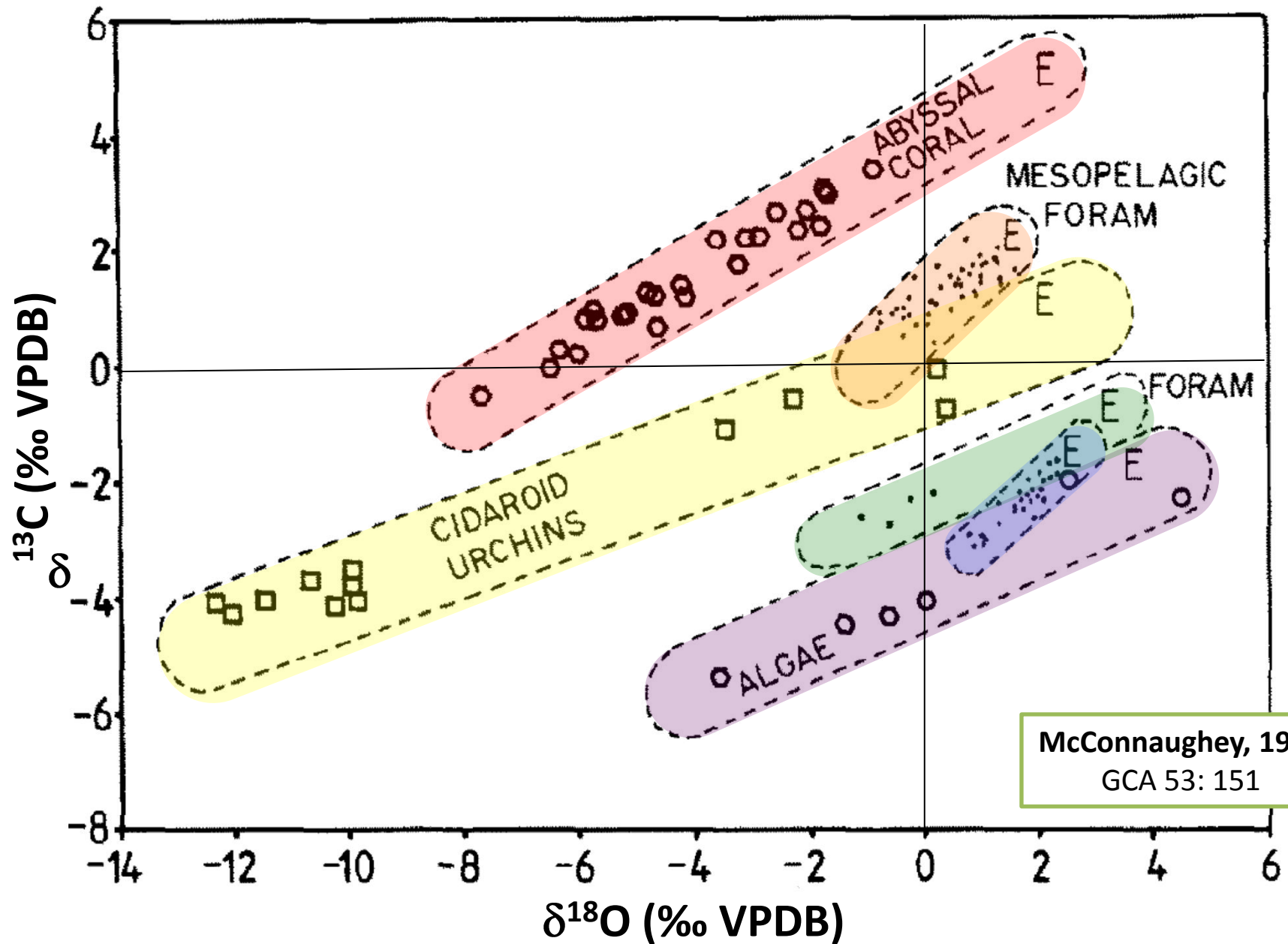
Test 1: In biotic calcite, $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ vary linearly

- *Tested material varies shows this linear variation*
- *Similar to other microbialites, both marine and lacustrine*

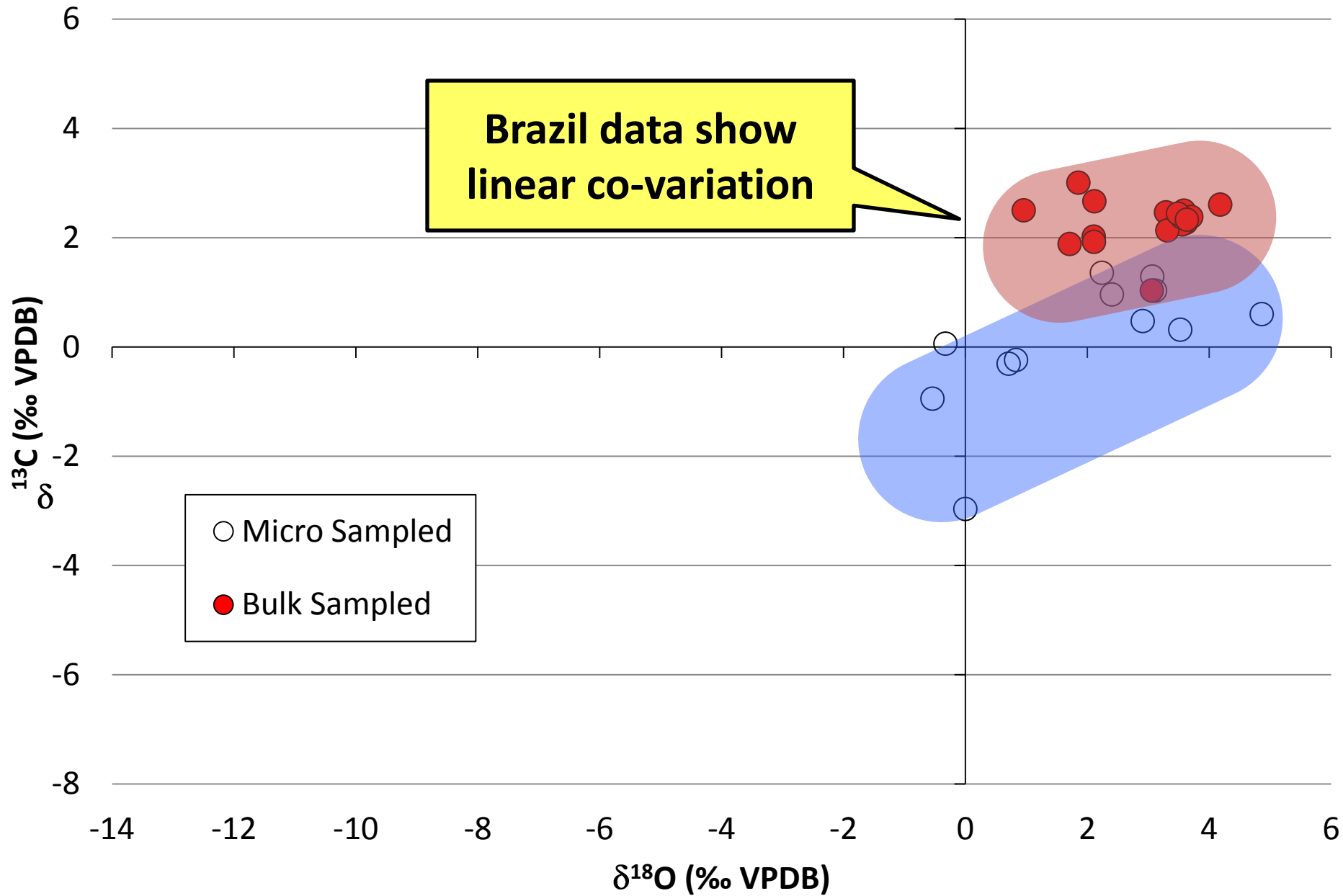
Test 2: In calcite, Biotic Sr/Ca > Abiotic Sr/Ca

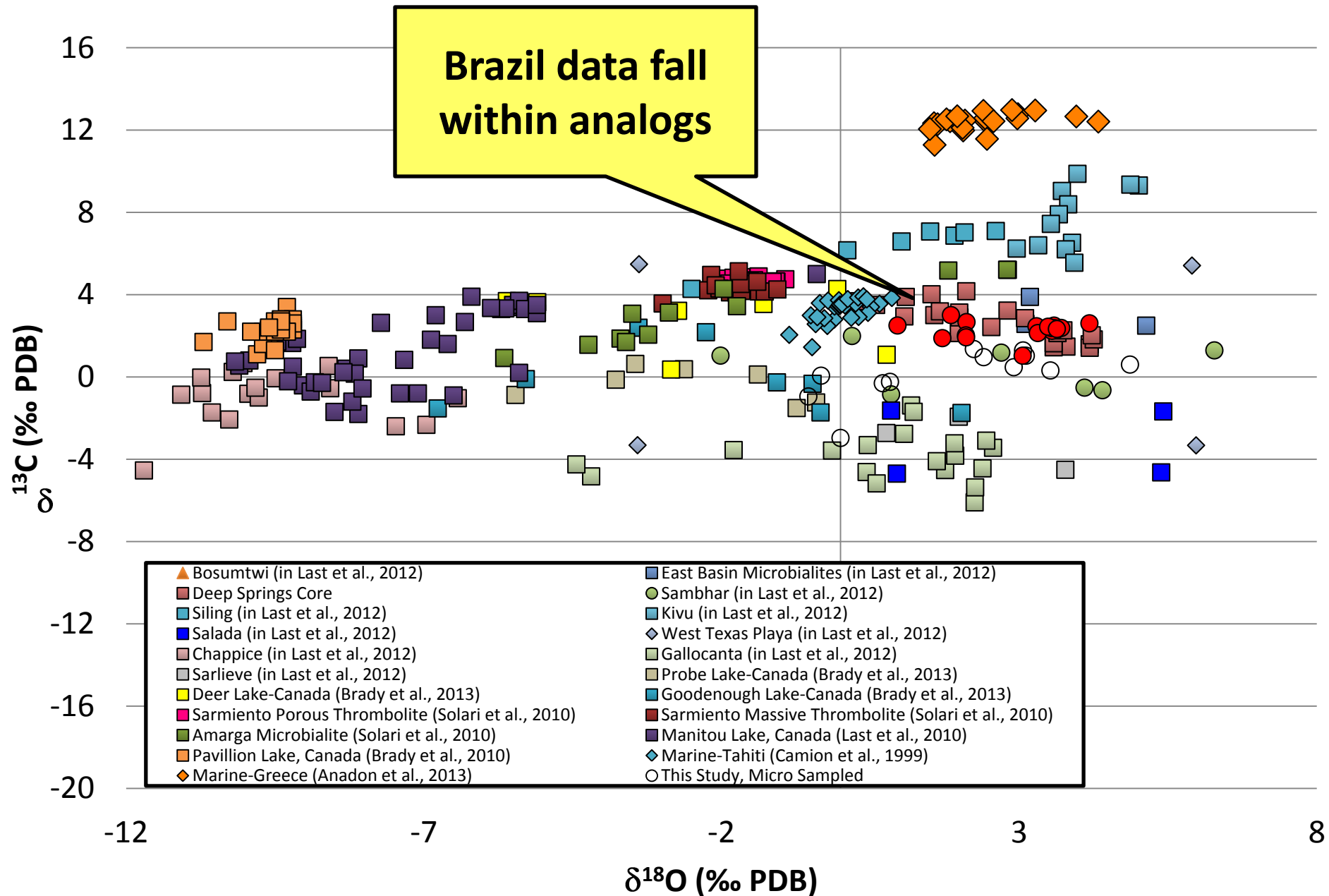
- *Micro Samples have Mg/Ca between High-Mg calcite and dolomite*
 - *Probably from mixing High-Mg calcite and dolomite*
 - *Composition is similar to seep and lake carbonate*
- ***Bulk Samples are mostly calcitic and shows “Biotic” Sr enrichment***

Test 1: Biotic $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ vary linearly



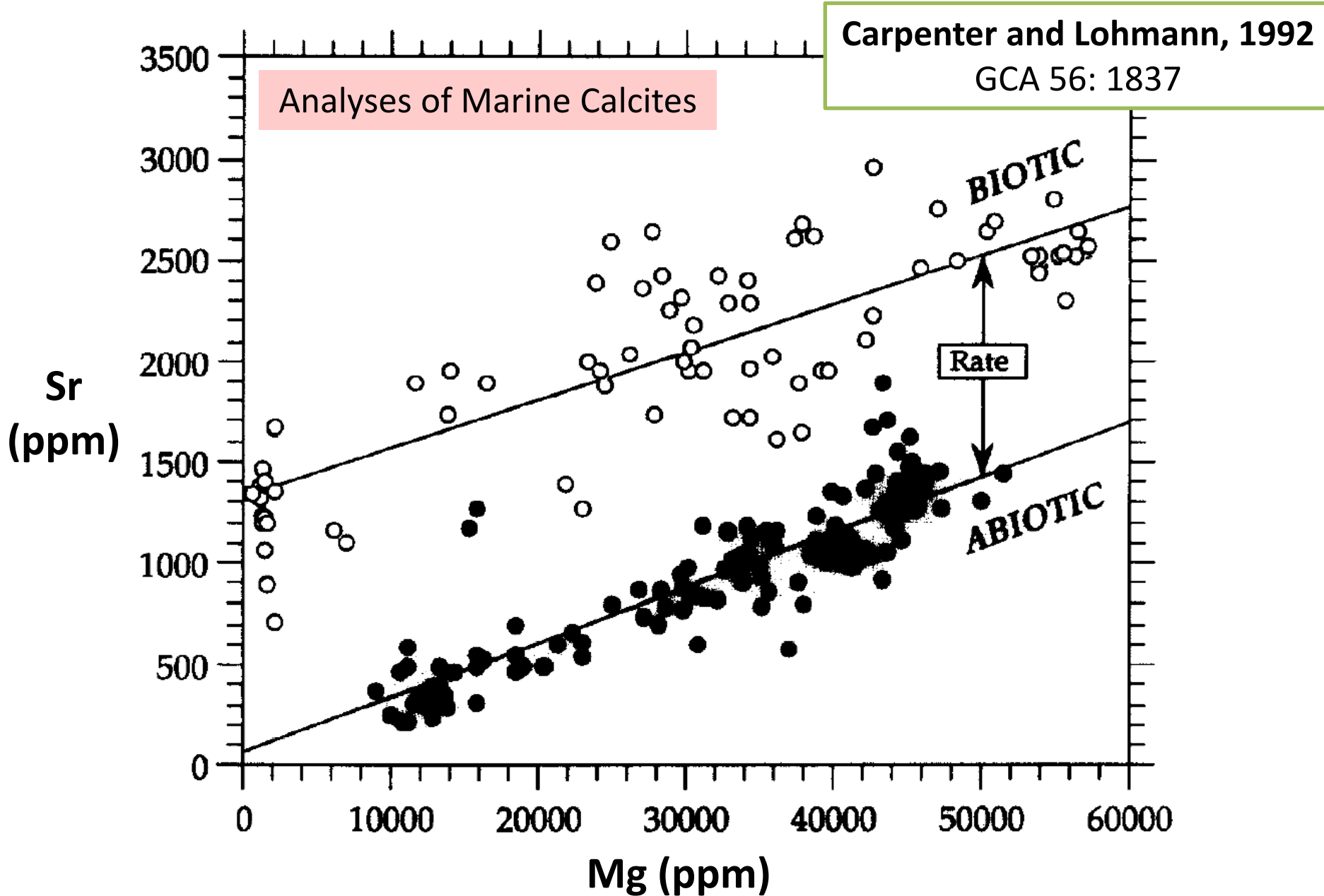
McConnaughey, 1989
GCA 53: 151





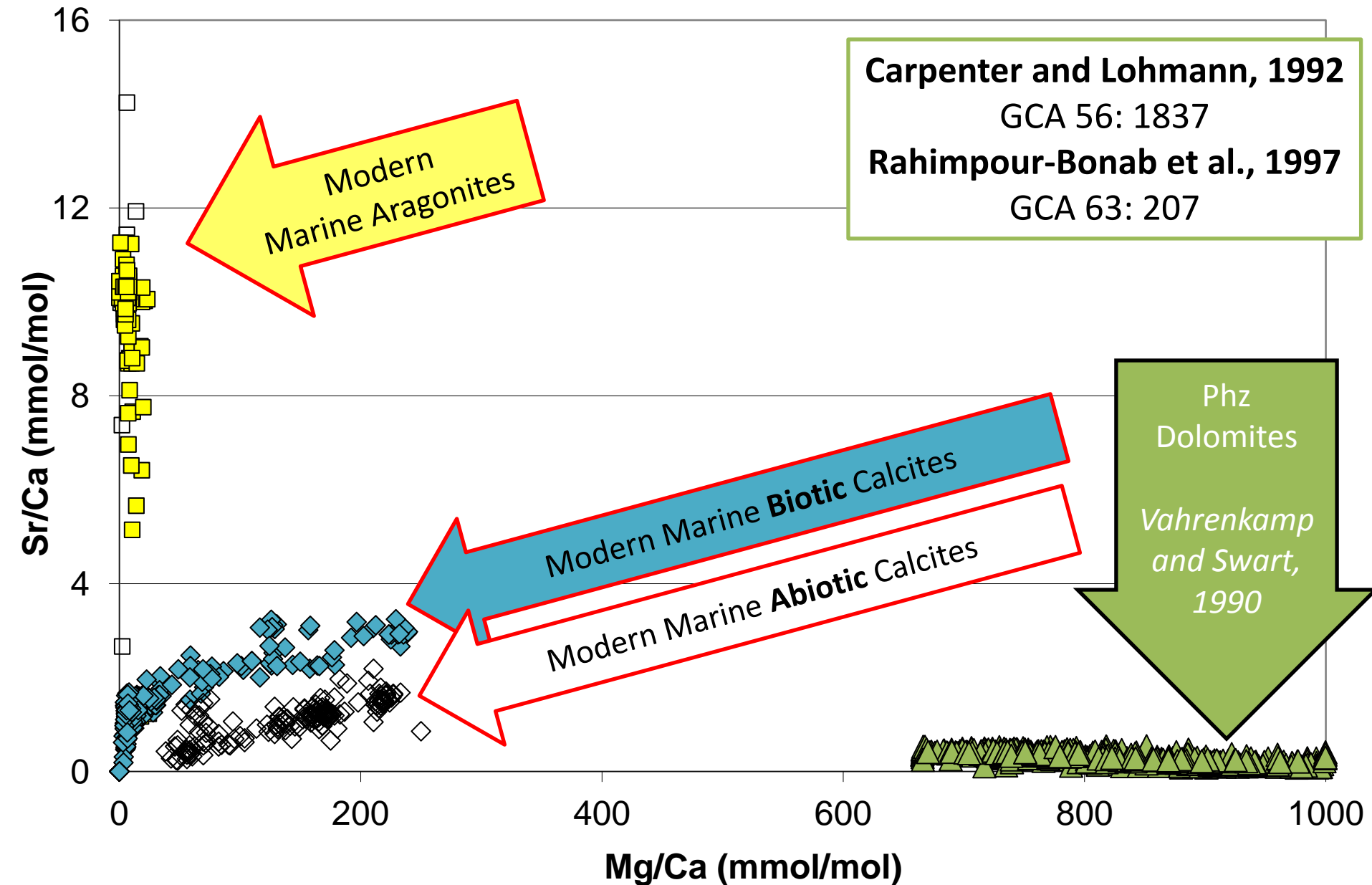
Test 2: Biotic Sr/Ca > Abiotic Sr/Ca

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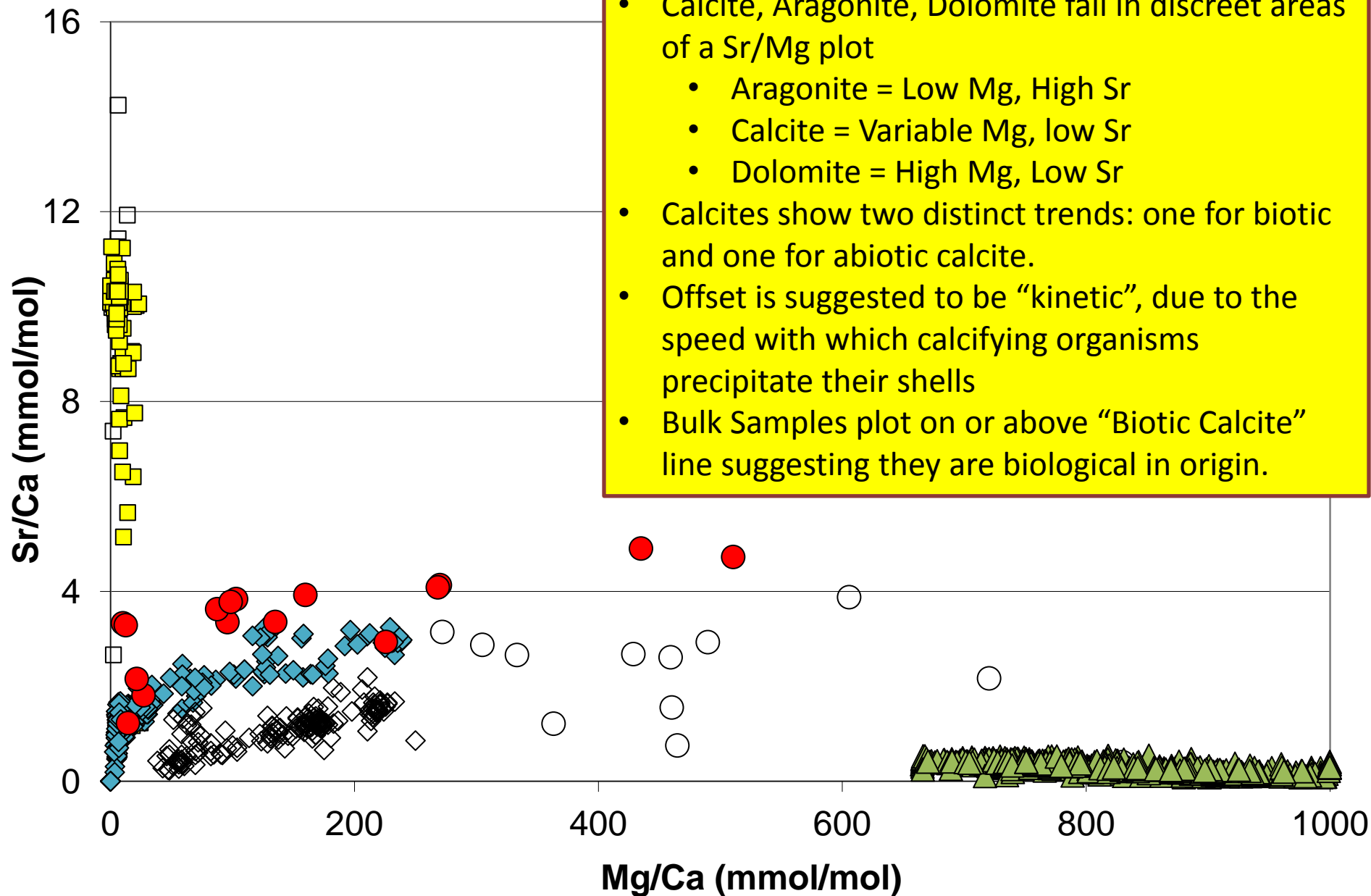
Sr/Mg in Sedimentary Carbonates

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Sr/Mg in Sedimentary Carbonates

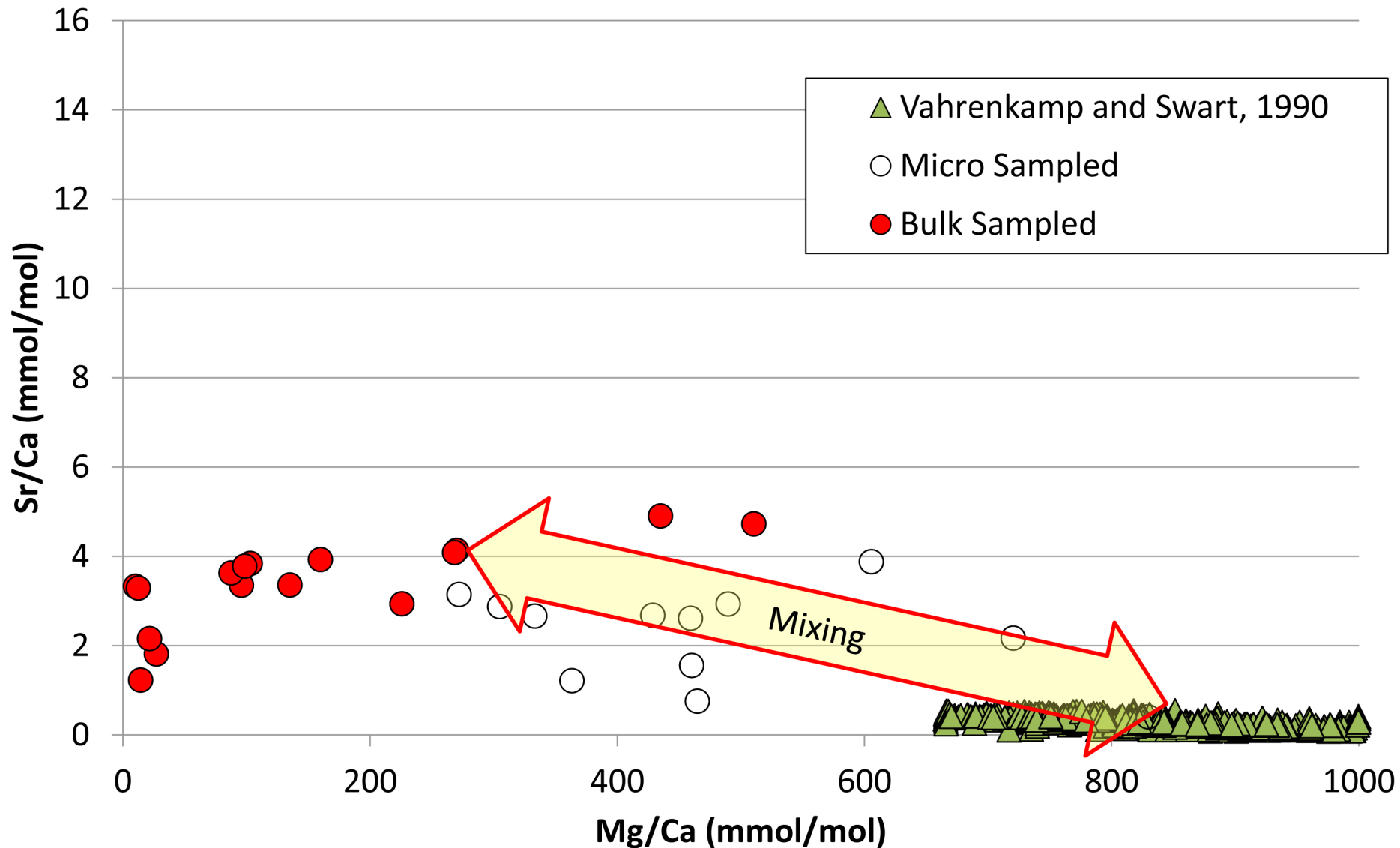
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Data vs. Phanerozoic Dolomite Compilation

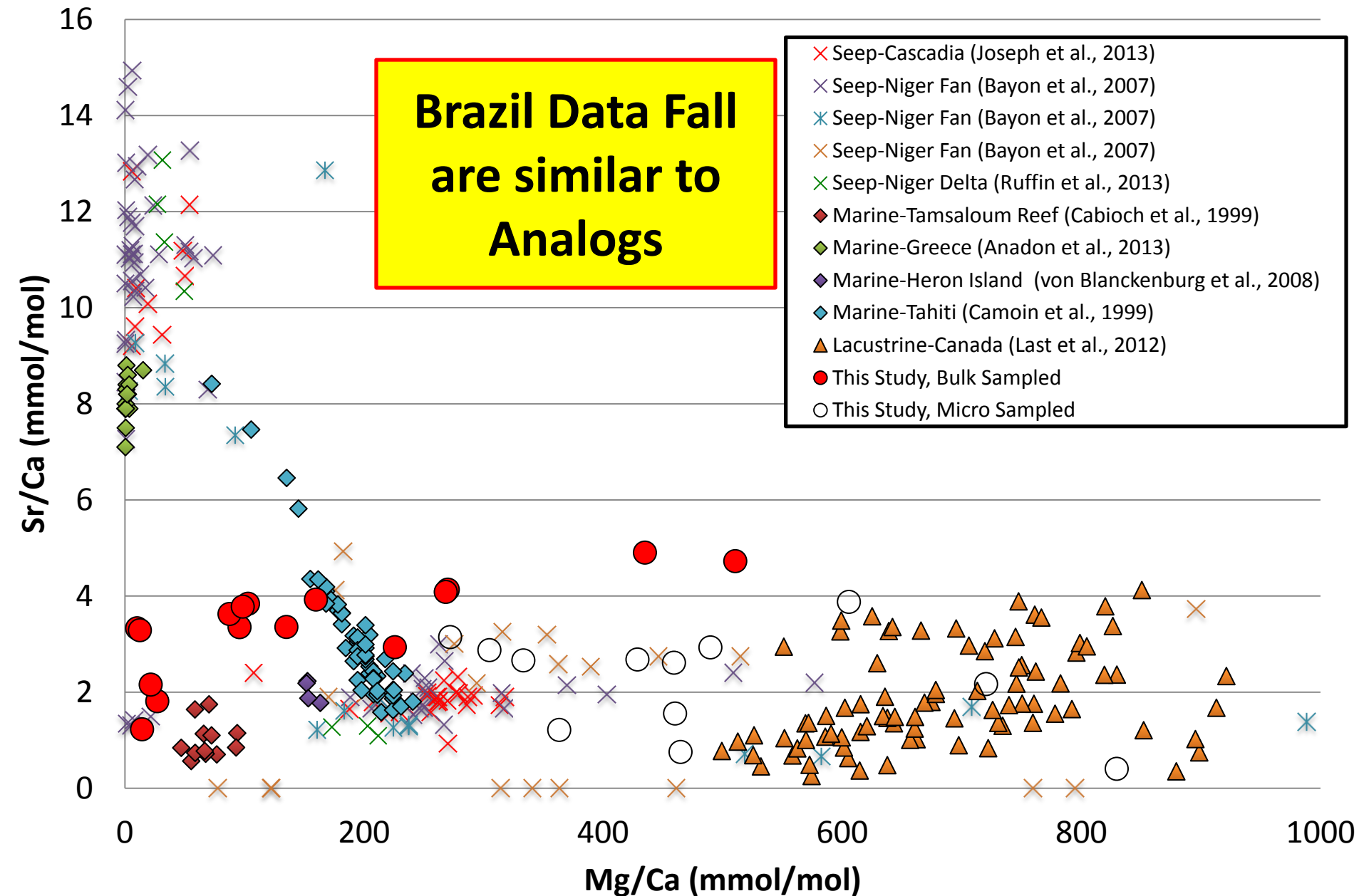
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*Micro Sample are likely mixed dolomite and calcite,
while Bulk Samples are likely mostly calcite*



This Study vs. Seep, Lake and Marine Analogs

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Project Funding—*ExxonMobil*

Project Samples—*ANP Brazil*

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Institutional Support

Iowa State University and Western Michigan University

