Field Observations of acidification-driven carbonate mineral dissolution

Cross, J.N.¹,²*, Mathis, J.T.¹,², Byrne, R.H.³, and Bates, N.R.⁴

¹University of Alaska, Fairbanks Ocean Acidification Research Center, 905 N. Koyukuk Dr., Fairbanks, AK 99775
²NOAA Pacific Marine Environmental Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115
³USF College of Marine Science, 140 Seventh Ave. South, St. Petersburg, FL 33701
⁴Bermuda Institute of Ocean Sciences, 17 Biological Lane, Ferry Reach, St. Georges, GE01, Bermuda
Global calcium carbonate dissolution

Impact of Anthropogenic CO₂ on the CaCO₃ System in the Oceans
Richard A. Feely,¹,* Christopher L. Sabine,¹ Kitack Lee,² Will Berelson,³ Joanie Kleypas,⁴ Victoria J. Fabry,⁵ Frank J. Millero⁶

50 – 70% OF CARBONATE PRODUCED IS DISSOLVED IN THE UPPER OCEAN.

Direct observations of basin-wide acidification of the North Pacific Ocean
Robert H. Byrne,¹ Sabine Mecking,² Richard A. Feely,³ and Xuewu Liu¹

High-Mg Calcite – Aragonite – Calcite
Understanding Environmental Impacts

Duration • Intensity • Extent

Pteropod exposed to ocean pH expected in 2100!


Early life stages of Red King Crab

Alaska Fisheries Science Center

Red King Crab habitat (Paralithodes camtschaticus)

Blue King Crab habitat (Paralithodes platypus)
Observations show that undersaturations are already present in the Bering Sea.
Direct observations of geochemical dissolution

Alkalinity changes in the Sargasso Sea: geochemical evidence of calcification?
Nicholas R. Bates, Anthony F. Michaels, Anthony H. Knap

Dissolution of Carbonate Sediments Under Rising pCO₂ and Ocean Acidification: Observations from Devil’s Hole, Bermuda
Andreas J. Andersson · Nicholas R. Bates · Fred T. Mackenzie
Direct observations of geochemical dissolution

Conservative and non-conservative variations of total alkalinity on the southeastern Bering Sea shelf

Jessica N. Cross a,*, Jeremy T. Mathis b,1, Nicholas R. Bates c,2, Robert H. Byrne d,3
Indirect observations of geochemical dissolution

TIME SERIES RECORDS OF THE DURATION AND INTENSITY OF CORROSIVE CONDITIONS CAN SHOW IF DISSOLUTION IS POSSIBLE.
Mechanisms driving geochemical dissolution

ANTHROPOGENIC ACIDIFICATION IS NOT THE ROOT CAUSE OF ALL CARBONATE MINERAL DISSOLUTION.

- Biological pump
- Natural volcanic laboratories
- Upwelling systems
- Reduction of calcification
- Biodegradation
- Mechanical breakdown

Dissolution of Carbonate Sediments Under Rising $p$CO$_2$ and Ocean Acidification: Observations from Devil’s Hole, Bermuda

Andreas J. Andersson · Nicholas R. Bates · Fred T. Mackenzie
The Anthropogenic Contribution

We estimate approximately 66.5 μmol kg⁻¹ of anthropogenic CO₂ is dissolved in the Pacific Arctic.

The Anthropogenic Contribution

THESE PERSISTENT UNDERSATURATIONS RESULT IN CARBONATE MINERAL DISSOLUTION.

Without anthropogenic CO$_2$, these undersaturations are **too weak** and **too short** to cause dissolution.

Charting the Way Forward
In-situ observations of geochemical dissolution

Volcanic carbon dioxide vents show ecosystem effects of ocean acidification
Jason M. Hall-Spencer¹, Riccardo Rodolfo-Metalpa¹, Sophie Martin¹, Emma Ransome¹, Maoz Fine³,⁴, Suzanne M. Turner³, Sonia J. Rowley¹, Dario Tedesco⁵,⁶ & Maria-Cristina Buia⁸

Changes in pteropod distributions and shell dissolution across a frontal system in the California Current System
N. Bednaršek¹,²,⁴, M. D. Ohman²

Extensive dissolution of live pteropods in the Southern Ocean
N. Bednaršek¹,²,³, G. A. Tarling¹*, D. C. E. Bakker², S. Fielding¹, E. M. Jones⁴, H. J. Venables¹, P. Ward¹, A. Kuzirian⁷, B. Lézé², R. A. Feely⁵ and E. J. Murphy¹

Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem
N. Bednaršek¹, R. A. Feely¹, J. C. P. Reum², B. Peterson³, J. Menkel⁴, S. R. Alin¹ and B. Hales⁵
Broad scale sedimentary response over continental shelves

‘A geological marker for the Anthropocene Epoch’
Summary

- Ecosystem level concerns are driving observations of acidification-driven dissolution.
- Geochemical and SEM evidence shows shallow water dissolution.
- Broad sedimentary response of high-Mg calcites expected by 2100.
Questions?