

# Zunli Lu

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## EDUCATION AND HONORS

**Ph.D. in Geology**, expected spring 2008, University of Rochester

- ◆ Dissertation: "Tracing the organic source of gas hydrates at active margins using iodine-129"  
Advisor: Udo Fehn

- ◆ MARGINS Student Prize for outstanding presentation at AGU 2007 (honorable mention)

**M.S. in Geology**, May 2005, University of Rochester

- ◆ Sproull Fellowship (2003-2005)

**B.S. in Geochemistry**, June 2002, Nanjing University, China

- ◆ Renmin Scholarship (1998-2001)
- ◆ Thesis with High Distinction (2002)

## RESEARCH EXPERIENCE

- ◆ *"Tracing the organic source of gas hydrates by iodine isotope system at Central (ODP 204) and Northern Cascadia Margin (IODP 311)":*

Iodine-129 system was applied to the pore waters collected at Central and Northern Cascadia Margins. The biophilic behavior of iodine and the close association between iodine and methane during transportation make the iodine isotopic system a powerful tool for identifying source formations and fluid pathways. We identified that a large fraction of methane in gas hydrates has old sources and is transported into the present locations from source regions of Eocene age, through fluid conduits such as fractures and faults.

- ◆ *"Numerical modeling of iodine release by organic matter degradation in marine sediments associated with gas hydrates":*

A numerical model was developed and applied to the drilling sites of ODP/IODP at Pacific Margins, in order to simulate the transport of deep-sourced old iodine and the in-situ release of younger iodine from local organic matter by microbial activity. This model allows us to quantify the contributions of local and deep sources to the pore water iodine and the associated methane in the hydrate system.

- ◆ *"Kinetics of iodine release during thermal decomposition of organic matter by laboratory pyrolysis technique":*

Investigate the main temperature window for iodine release from deeply buried marine organic matters by laboratory pyrolysis. Marine sediments are heated from room temperature to 800°C under constant gas flow and iodine released from the sediments is collected in a trap solution for concentration measurements. The main iodine window changes as different heating rates applied, similar to hydrocarbon generation, which can be extrapolated to natural geologic thermal history.

◆*“Research cruises targeting gas hydrates in Japan Sea, summer 2005 and 2006”:*

I participated in two research cruises to the methane seeps near Sado Island, Japan Sea. We recovered over 20 sediment cores, during each cruise. My main responsibilities include sampling for gas hydrate, pore waters, diatom/nannofossils, and paleomagnetism analysis, although I also contributed to many other operations (core recovery, onboard chemical analysis etc.).

◆*“Iodine age of fluids collected from mud volcanoes, Costa Rica”:*

Focused fluid expulsion at cold vents is a common feature of subduction zones, serving as an important backflux of water and volatile elements to the oceanic reservoir. The strong enrichment of iodine in fluids collected from mounds along the Central American convergent Margin allowed the determination of  $^{129}\text{I}/\text{I}$  ratios. A large proportion of iodine ages calculated from  $^{129}\text{I}/\text{I}$  ratios are older than 25 Ma, indicating derivation from old sources in the upper plate. Both the iodine concentrations and ages determined in this study for the mounds are comparable with the reported values for hydrate fields at accretionary margins, indicating that iodine and associated organic carbon cycling at both erosional and accretionary margins may occur on similar time scales.

◆*“Iodine dating of organic source for gas hydrate at Nankai Trough”:*

We report  $^{129}\text{I}/\text{I}$  ratios in pore waters from three deep cores in the eastern Nankai Trough gas hydrate field. For the first time, the results demonstrate that the origin of I varies considerably over geologically different parts of a gas hydrate area. Iodine and, by association, methane on the outer ridge is derived from early Miocene to Pliocene forearc sediments, transported through the active faults system found there, while the main source regions for the forearc basin probably is the old accretionary wedge related to an earlier subduction configuration of Eocene age which acts as backstop in the current subduction system.

◆*“Geochemical anomalies related to marine gas hydrates at South China Sea”:*

Major, trace elements, and C, H, O, Sr, Nd, Pb, isotopic compositions were analyzed in pore waters collected from a potential gas hydrate field in South China Sea, in order to detect the geochemical anomalies indicating the presence of gas hydrates.

◆*“Precambrian marine environmental changes with isotopic tracers”:*

Primary carbon isotope evolution recorded in marine carbonate rocks is particularly useful for Neoproterozoic chemostratigraphic correlation and paleoenvironment reconstruction. We studied C, O and Sr isotopes of two successions of the Neoproterozoic formations in Yangtze platform, South China. The results indicated two oceanic overturn events in these formations.

◆*“Secular evolution and sources of Pb and Nd in the central Pacific seawater”:*

The evolution of dissolved Pb and Nd isotope ratios of seawater are recorded by hydrogenetic ferromanganese crusts in central North Pacific back to the latest Cretaceous. Pb in North Pacific seawater has been mainly controlled by eolian dust from North America prior to 50 Ma and after 40 Ma from Asia. The rise of Nd isotope ratios of Pacific seawater during the Cenozoic has most likely been caused by the increasing volcanic activity and erosion of the volcanic arcs around the Pacific.

## RESEARCH SKILLS

- ◆ AMS analysis (Sample preparation for iodine-129 and chlorine-36 analysis)
- ◆ Numerical Modeling of Fluid and Geochemical Systems (Solute transport, reaction, organic matter degradation, methane generation and gas hydrate deposition)
- ◆ ICP-MS (Halogens, trace elements including Hg on Finnigan Element 2 and Thermal X7)
- ◆ TIMS (Sr, Nd, Pb column chemistry and isotope analysis on Finnigan Triton TI)
- ◆ Ion chromatography (Cation and anion concentrations on DIONEX ICS-1000)
- ◆ Electron Microprobe (JEOL JXA8800M)

## PUBLICATIONS

- Lu, Z., and Fehn, U., Long-term organic carbon recycling at active continental margins (in preparation)
- Lu, Z., Fehn, U., and Hensen, C., Iodine isotope and numerical modeling results from northern Cascadia Margin (IODP 311): implications for sources of gas hydrates (in preparation)
- Lu, Z., Tomaru, H., and Fehn, U., Iodine ages of pore waters at Hydrate Ridge (ODP Leg 204), Cascadia Margin: implications for sources of methane in gas hydrates: Earth and Planetary Science Letters (in press).
- Lu, Z., Hensen, C., Fehn, U., and Wallmann, K., 2007, Old iodine in fluids venting along the Central American convergent margin: Geophysical Research Letters 34, L22604, doi:22610.21029/22007GL031864.
- Lu, Z., Fehn, U., Tomaru, H., Elmore, D., and Ma, X., 2007, Reliability of 129I/I ratios produced from small sample masses: Nuclear Instruments and Methods in Physics Research B, v. 259, p. 359-364.
- Tomaru, H., Lu, Z., Fehn, U., Murakami, Y., and Matsumoto, R., 2007 Age variation of pore water iodine in the eastern Nankai Trough, Japan: evidence for different methane sources in a large gas hydrate field: Geology, v.35, p.1015-1018.
- Tomaru, H., Lu, Z., Snyder, G.T., Fehn, U., Hiruta, A., and Matsumoto, R., 2007, Origin and age of pore waters in an actively venting gas hydrate field near Sado Island, Japan Sea: interpretation of halogen and 129I distributions: Chemical Geology, v. 236, p. 350-366.
- Tomaru, H., Fehn, U., Lu, Z.L., and Matsumoto, R., 2007, Halogen systematics in the Mallik 5L-38 gas hydrate production research well, Northwest Territories, Canada: Implications for the origin of gas hydrates under terrestrial permafrost conditions: Applied Geochemistry, v. 22, p. 656-675.
- Tomaru, H., Ohsawa, S., Amita, K., Lu, Z.L., and Fehn, U., 2007, Influence of subduction zone settings on the origin of forearc fluids: Halogen concentrations and I-129/I ratios in waters from Kyushu, Japan: Applied Geochemistry, v. 22, p. 676-691.
- Fehn, U., Lu, Z., and Tomaru, H., 2006, Data Report: 129I/I ratios and halogen concentrations in pore water of Hydrate Ridge and their relevance for the origin of gas hydrates: A progress report: Proceedings of the Ocean Drilling Program, Scientific Results, v. 204.
- Lu, Z., Ling, H.F., Zhou, F., Jiang, S., Chen, X., and Zhou, H., 2005, Variation of the Fe/Mn ratio of ferromanganese crusts from the Central North Pacific: implication for paleoclimate changes: Progress in Natural Science, v. 15, p. 530-537.
- Ling, H.F., Jiang, S.Y., Frank, M., Zhou, H.Y., Zhou, F., Lu, Z.L., Chen, X.M., Jiang, Y.H., and Ge, C.D., 2005, Differing controls over the Cenozoic Pb and Nd isotope evolution of

deepwater in the central North Pacific Ocean: Earth and Planetary Science Letters, v. 232, p. 345-361.

## SELECTED TALKS

Lu, Z., Hensen, C., and Fehn, U., The iodine release during organic matter degradation at Northern Cascadia Margin: a numerical approach. AGU Fall Meeting, San Francisco, CA, 2007.

Lu, Z., Fehn, U., and Tomaru, H., Preliminary results of  $^{129}\text{I}/\text{I}$  ratios in pore waters from the northern Cascadia margin (IODP 311). IODP 311 Post-cruise Meeting, Paris, Apr. 2007.

Lu, Z., Fehn, U., and Tomaru, H., Fluid flow and origin of gas hydrate at active margins. Hubbert Quorum, USGS, CA, 2006.

Lu, Z., Fehn, U., and Tomaru, H., Iodine and bromine concentrations in pore waters from two gas hydrate fields: IODP 311 and ODP 204. AGU Fall Meeting, San Francisco, CA, 2006.

Lu, Z., Fehn, U., and Tomaru, H., Pore water iodine concentrations and  $^{129}\text{I}/\text{I}$  ratios of the Hydrate Ridge (ODP 204): Implication for the origin of gas hydrates. Goldschmidt 05, Idaho, US, May 2005.

Lu, Z., Fehn, U. and Tomaru, H., Long distance migration of fluids in the Cascadia margin: evidence from iodine isotopic composition. AGU Fall Meeting, San Francisco, CA, 2005.

Lu, Z., Fehn, U., and Tomaru, H., A Test of Mass Dependence of  $^{129}\text{I}$  Ratios in AMS Determination. AMS-10, Berkeley, CA, 2005.

Lu, Z., Ling, H.F., Jiang, S.Y., Zhou, F., Implications of Fe/Mn ratios in Fe-Mn crusts for paleoclimate changes. Goldschmidt 2003.

## COLLABORATORS

Hensen C. and Wallmann K., GEOMAR, Kiel, Germany

Tomaru H., New Energy Resources Research Center, Hokkaido, Japan

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PRIME Lab, Purdue University, US

Isotrace Lab, University of Toronto, Canada

## PROFESSIONAL AFFILIATIONS

American Geophysical Union

Geological Society of America

Geochemical Society

American Association of Petroleum Geologists

## TEACHING ASSISTANT EXPERIENCE

◆ Environmental Geophysics

◆ Energy and Mineral Resources

◆ Energy Decisions

◆ Supervising two senior theses