

Max K. Lloyd

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EDUCATION

- PhD Geochemistry, California Inst. of Technology, May 2018
Clumped and intramolecular isotopic perspectives on the behavior of organic and inorganic carbon in the shallow crust and deep biosphere.
Adv: John Eiler
- BA Geology, Amherst College, *summa cum laude*, 2012
Evaluating the regional extent, timing, and conditions of paleoproterozoic metamorphism in southwestern Montana.
Adv: Jack Cheney

PROFESSIONAL EXPERIENCE

- 2020 - Assistant Research Professor, Penn State
2018 - 2020 Agouron Geobiology Postdoctoral Fellow, UC Berkeley
2018 Postdoctoral Scholar, UC Berkeley
2012 - 2017 Research Assistant, California Inst. of Technology
2011 - 2012 Undergraduate Research Assistant, Amherst College
2011, summer Summer Student Fellow, Woods Hole Oceanographic Inst.
2009 - 2010 Undergraduate Research Assistant, Stanford University

PUBLICATIONS IN REVIEW

- Lloyd, M.K.**, McClelland, H.L.O., Antler, G., Bradley, A.S., Halevy, I., Junium, C.K., Wankel, S.D., Zerkle, A.L., In Review. The isotopic imprint of life on an evolving planet. In revision at *Space Science Reviews*.
- Lloyd, M.K.**, Eldridge, D.L., Stolper, D.A., In Review. Clumped $^{13}\text{CH}_2\text{D}$ and $^{12}\text{CHD}_2$ compositions of methyl groups from wood and synthetic monomers: methods, experimental and theoretical calibrations, and initial results. In review at *Geochimica et Cosmochimica Acta*.

REFEREED PUBLICATIONS

12. Chamberlain, C.P., Ibarra, D.E., **Lloyd, M.K.**, Kukla, T., Sjostrom, D., Gao, Y., Sharp, Z.D., 2020. Triple oxygen isotopes of meteoric hydrothermal systems implications for palaeoaltimetry. *Geochemical Perspectives Letters* 15, 69.
11. Chang, B., Li, C., Liu, D., Foster, I., Tripathi, A., **Lloyd, M.K.**, Maradiaga, I., Luo, G., An, Z., She, Z., Xie, S., Tong, J., Huang, J., Algeo, T.J., Lyons, T.W., Immenhauser, A., 2020. Massive formation of early diagenetic dolomite in the Ediacaran ocean: Constraints on the dolomite problem. *PNAS* 117, 1400514014.
10. Greule, M., Moossen, H., **Lloyd, M.K.**, Geilmann, H., Brand, W.A., Eiler, J.M., Qi, H., Keppler, F., 2020. Three wood isotopic reference materials for $\delta^2\text{H}$ and $\delta^{13}\text{C}$ measurements of plant methoxy groups. *Chemical Geology* 533, 119428.
9. Douglas, P.M.J., Moguel, R.G., Anthony, K.M.W., Wik, M., Crill, P.M., Dawson, K.S., Smith, D.A., Yanay, E., **Lloyd, M.K.**, Stolper, D.A., Eiler, J.M., Sessions, A.L., 2020. Clumped Isotopes Link Older Carbon Substrates With Slower Rates of Methanogenesis in Northern Lakes. *Geophysical Research Letters* 47, e2019GL086756.
8. Eldridge, D.L., Korol, R., **Lloyd, M.K.**, Turner, A.C., Webb, M.A., Miller, T.F., Stolper, D.A., 2019. Comparison of Experimental vs Theoretical Abundances of $^{13}\text{CH}_3\text{D}$ and $^{12}\text{CH}_2\text{D}_2$ for Isotopically Equilibrated Systems from 1 to 500 °C. *ACS Earth Space Chem.* 3, 27472764.

7. Xie, H., Ponton, C., Formolo, M.J., Lawson, M., Peterson, B.K., **Lloyd, M.K.**, Sessions, A.L., Eiler, J.M., 2018. Position-specific hydrogen isotope equilibrium in propane. *Geochimica et Cosmochimica Acta* 238, 193207.
6. **Lloyd, M.K.**, Ryb, U., Eiler, J.M., 2018. Experimental calibration of clumped isotope reordering in dolomite. *Geochimica et Cosmochimica Acta* 242, 120.
5. Ryb, U., **Lloyd, M.K.**, Stolper, D.A., Eiler, J.M., 2017. The clumped-isotope geochemistry of exhumed marbles from Naxos, Greece. *Earth and Planetary Science Letters* 470, 112.
4. **Lloyd, M.K.**, Eiler, J.M., Nabelek, P.I., 2017. Clumped isotope thermometry of calcite and dolomite in a contact metamorphic environment. *Geochimica et Cosmochimica Acta* 197, 323344.
3. Eiler, J.M., Clog, M., Lawson, M., **Lloyd, M.**, Piasecki, A., Ponton, C., Xie, H., 2017. The isotopic structures of geological organic compounds. *Geological Society, London, Special Publications* 468, 5381.
2. Eiler, J., Cesar, J., Chimiak, L., Dallas, B., Grice, K., Griep-Raming, J., Juchelka, D., Kitchen, N., **Lloyd, M.**, Makarov, A., Robins, R., Schwieters, J., 2017. Analysis of molecular isotopic structures at high precision and accuracy by Orbitrap mass spectrometry. *International Journal of Mass Spectrometry* 422, 126142.
1. Sousa, F.J., Saleeby, J., Farley, K.A., Unruh, J.R., **Lloyd, M.K.**, 2016. The southern Sierra Nevada pediment, central California. *Geosphere* GES01369.1.

**SEMINARS AND
SELECTED
CONFERENCE
ACTIVITY
(*INVITED)**

- *Lloyd, M.K.**, 2020. Isotopic evidence for pervasive methylotrophy in coals. Gordon Research Conference, Deep Carbon Section (Cancelled due to COVID-19).
- Lloyd, M.K.**, 2019. Terrestrial climate records from clumped isotope compositions of wood methoxyl groups. Oral presentation at AGU Fall Meeting 2019, San Francisco, CA.
- Lloyd, M.K.**, Ibarra, D.E., Chamberlain, C.P., Pester, N.J., Seyfried, W.E., 2019. Triple oxygen isotopes of fluids and solids from hydrothermal systems. Poster presentation at Goldschmidt 2019, Barcelona, Spain.
- *Lloyd, M.K.**, 2019. The behavior of carbonates during burial diagenesis: Insights from a compilation of 1,500 clumped isotope compositions. International Clumped Isotope Workshop, Long Beach, CA.
- *Lloyd, M.K.**, 2018. Clumped and position-specific isotopes and the global carbon cycle. International Space Science Institute Workshop, Bern, Switzerland.
- *Lloyd, M.K.**, 2018. The C1 carbon cycle: Tracking the production and destruction of lignin methoxy groups with site-specific isotope analyses. Gordon Research Conference, Organic Geochemistry - August 2018.
- *Lloyd, M.K.**, Dawson, K., Douglas, P.M.J., Eiler, J.M., 2018. How reversible is methylotrophic methanogenesis? Towards an isotopologue-specific understanding of methane metabolisms. Oral presentation at Goldschmidt 2018, Boston, MA.
- *Lloyd, M.K.**, 2018. Intramolecular isotopic perspectives on the terrestrial carbon cycle from lignin methoxyl groups. CU Boulder Geobiology Seminar - February 2018.
- Lloyd, M.K.**, Akker, V., Herwegh, M., and Eiler, J.M. (2017). Steady growth or fits and starts: observing the style of and controls on carbonate recrystallization in an Alpine fold and thrust belt. Oral presentation at AGU 2017, New Orleans, LA.
- *Lloyd, M.K.**, 2017. Quantifying shallow crustal tectonic processes with clumped isotope thermometry. USC Lithospheric Dynamics Seminar - November 2017.
- Lloyd, M.**, Trembath-Reichert, E., Feakins, S.J., Schimmelmann, A., Mastalerz, M., Sessions, A.L., and Eiler, J.M., (2017). Observing the biodegradation of complex organic substrates by site-specific isotopic analyses. Oral presentation at Goldschmidt 2017, Paris, France.
- *Lloyd, M.**, 2017. The formation and degradation of organic polymers recorded by the 'clumped' isotopic compositions of methoxy groups. Princeton U. Geochemistry Seminar -

February 2017.

***Lloyd, M.**, 2017. Transformations of carbonate + organic carbon in the shallow crust and deep biosphere recorded by multiply-substituted isotopologues. UC Berkeley Geochemistry Seminar - February 2017.

***Lloyd, M.**, 2017. Transformations of carbon(ate) in shallow crustal processes recorded by multiply-substituted isotopologues. Texas A&M Geochemistry Seminar - February 2017.

Lloyd, M., Feakins, S., Sessions, A., Schimmelman, A., and Eiler, J. (2016), Determination of clumped $^{13}\text{C}-^2\text{H}$ compositions of methoxyl groups in wood, lignin, and simple organic monomers. Poster presentation at 2016 Gordon Organic Geochemistry conference, Holderness, NH.

Lloyd, M. Eiler, J., and Nabelek, P. (2015), The clumped isotope geochemistry of dolomite and calcite in contact metamorphic environments. Oral presentation at Goldschmidt 2015, Prague, CZ.

Lloyd, M. and Eiler, J. (2014), Laboratory and natural constraints on the temperature limit for preservation of the dolomite clumped isotope thermometer. Poster presentation at AGU Fall Meeting 2014, San Francisco, CA, 15-19 Dec.

Lloyd, M. Eiler, J., and Nabelek, P. (2014), Carbonate clumped isotope thermometry of the Notch Peak contact metamorphic aureole. Poster presentation at Goldschmidt 2014, Sacramento, CA.

Lloyd, M., Cheney, J., Harms, T., (2012), Evaluating the timing, conditions, and regional extent of paleoproterozoic metamorphism in southwestern Montana. Poster presentation at 2012 GSA Northeastern Section Meeting, Hartford, CT, 18-20 Mar.

Lloyd, M., Shimizu, N., Wang, Z., and Zheng, Y., (2011), Constraining cooling rates of UHP metamorphic rocks with closure temperature geospeedometry: a case study from the Dabie orogen. Oral presentation at 2011 AGU Fall Meeting, San Francisco, CA, 5-9 Dec.

FELLOWSHIPS AND GRANTS

Agouron Institute Postdoctoral Fellowship, UC Berkeley 2018-2020
"Development and application of a terrestrial thermometer for ancient greenhouse climates" [\$142,000]

Walter F. Pond Prize, Amherst College Geology Department 2012
For most distinguished senior honors thesis [\$2,000]

Summer Student Fellowship, Woods Hole Oceanographic Institute 2011
Full support for a summer working in the ion microprobe lab at WHOI [\$7,700]

Richard M. Foose Award (2011), Amherst College Geology Department 2011
Awarded in support of summer field research [\$3,000]

TEACHING EXPERIENCE

Co-Teacher, ESPM-C225: Isotopics, UC Berkeley, 2019

- Planned course syllabus and direction for graduate-level isotope seminar with Prof. Todd Dawson
- Gave lectures and advised on student presentations

Teaching Assistant, Agouron International Geobiology Course, 2017

- Planned and implemented multi-hour lectures, lessons, and lab experiences during the week-long geochemistry module
- Advised students on the acquisition and interpretation of isotopic data throughout the six-week course

Teaching Assistant, California Inst. of Technology, 2012-2017

- Courses: Metamorphic Petrology, Igneous Petrology, Radiogenic Isotope Geochemistry, Organic Geochemistry

- Ran laboratory sections and review sessions, and gave guest lectures
- Graded problem sets and exams, and consulted on scope and direction for final projects and papers

Undergraduate Teaching Assistant, Amherst College, 2009-2012

- Courses: Introduction to Geology, Mineralogy, Metamorphic Petrology
- Planned and organized laboratory sections, advised and graded problem sets and exams

SERVICE AND OUTREACH

Reviewer: *Geochimica et Cosmochimica Acta* (9); *Nature Geoscience* (2); *Journal of the Geological Society* (1); *Basin Research* (1)

Session convener: Goldschmidt 2018, 03g: Building the crust top to bottom: Linking thermal, chemical, and deformational histories with petrochronology, thermochronology, and novel low-T techniques

Mentor: Undergraduate research mentor to

- Korbinian Thalhammer, UC Berkeley, 2018–2020 – Climatic and metabolic signals in the isotope composition of ancient plant tissues. Matriculating PhD student at Caltech.
- Iure Teixeira, Caltech, 2015 – Thermal and diagenetic history of a contact metamorphic aureole through texture-specific carbonate clumped isotope measurements. Now PhD candidate at University of Sao Paulo
- Youry Aglyamov, Caltech, 2014 – Unconventional techniques for scrambling clumped isotope compositions in carbonate minerals. Now PhD candidate at Cornell.

TECHNICAL EXPERIENCE

Gas-source IRMS: Comprehensive experience in the setup, maintenance, and operation of Nier-type electron-impact isotope ratio mass spectrometers (e.g., Thermo MAT 253, 253 Plus, Delta V). Uniquely proficient in the development, application, and interpretation of novel measurements of position-specific and multiply-substituted ('clumped') isotope compositions of unconventional analytes on next-generation ultra-high resolution mass spectrometers (e.g., Thermo MAT 253 Ultra, DFS, and Q Exactive Orbitrap).

GC-MS/GC-IRMS: Extensive experience in the maintenance and operation of gas chromatography systems for MS and IRMS applications. Especially skilled in the construction of new chromatographic systems and the development of new analytical procedures for unusual target molecules.

Numerical modeling: Proficient in the design and implementation of numerical finite-difference models for a variety of geochemical applications (e.g., heat flow, diffusion, isotopic exchange kinetics) in Scientific Python and Matlab.

Computation-intensive data analysis & database management: Extensive experience developing command-line and GUI-based software for the robust, streamlined extraction, computation, and analysis of complex isotope ratio mass spectrometry data in Python (some modules available at github.com/maxmansaxman).

Additional analytical & computational experience: SIMS, ICP-MS, EA-IRMS, TC/EA-IRMS, SEM, EMPA, XRD; ArcMap, Bash, R, HeFTy, Qtqt, Theriak-Domino

PROFESSIONAL ACTIVITY

International Clumped Isotope Workshop – IPGP, France, August 2017

Principles of Teaching and Learning in STEM – Caltech, California, Sept-Dec. 2015
Comprehensive course on the design and effective implementation of modern principles of

STEM education in university-level courses.

Data Carpentry Workshop – Caltech, California, June 2015

Thermodynamic Modeling in Theriak Domino – UMass Amherst, January 2012

Professional affiliations: AGU, MSA, Geochemical Society, EAG