BOOK REVIEW

Reconstructing Earth's Climate History. Inquiry-Based Exercises for Lab and Class. Kristen St John, R. Mark Leckie, Kate Pound, Megan Jones, Lawrence Krissek. Review by Dr Alexandra V. Turchyn
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These days, there are few scientific subjects that inspire as much misrepresentation of basic research as global climate change. There are no people in the field of Earth Systems science who refute the idea that climate has evolved over the history of Earth. It is a small stretch to add that, for what we are still learning about energy forcing and feedback on our planet, adding CO_2 to the atmosphere at the rate we are doing so is an experiment for which there are few natural analogues. However, the external community likes to take the incompleteness of the geological record or the analytical challenges of extracting quantitative information from muds, minerals and rocks deposited millennia or thousands of millennia back and use this to triumphantly declare victory. I face this personally with an obstreperous engineering colleague who delights in denouncing scientific work with a joy that belies his ignorance: 'There is no correlation between temperature and CO_2 over the last 500 million years'; 'We don't understand the link between CO_2 and feedbacks relating to climate' and finally, my favourite, 'If it ends up being so bad, we can just engineer our way out of it anyway'. We are on the precipice of a rapidly changing world and few of today's university graduates are able to read even a short article about our changing planet and critically evaluate what is real and what is hype. *Reconstructing Earth History* aims to bridge this gap and empower students to face the world with an understanding of where the scientific data come from that allow us to say we are performing an interesting experiment on our planet today.

In many ways, the field of palaeoclimate reconstruction has the most to offer in our understanding of: how our planet responds to climate perturbations; what the critical feedbacks are; and how we make a link between well-constructed Quaternary climate change and climate change over longer periods of geological time. Unfortunately, palaeoclimate reconstruction is also difficult. Direct measurements of past climate are not possible; we therefore employ proxies which allow us to infer variations and transients in past climate. These proxies can be purely geological (rock type changes, sedimentary analysis) and/or geochemical (isotope ratios, major elemental ratios). Often the link between these proxy analyses and a quantitative answer is tenuous or relies on assumptions of past environmental conditions. This can lead to conflicting interpretations, which is fodder for climate sceptics. However, we are also learning much from the geological record about how climate evolves and changes; as our analytical capabilities also evolve, we are able to say with increasing certainty where things have been and where they might be going.

Reconstructing Earth History is a classroom and laboratory guide with exercises for students based on real palaeoclimate data, designed to help students learn and understand the scientific basis on which climate data are reconstructed. There are 14 chapters all filled with exercises; these would make an excellent laboratory sequence for an Introduction to the Palaeoclimate course. The first four chapters are introductory (coring, seafloor sediments, biostratigraphy and magnetostratigraphy). Chapters 5–14 are called 'case studies', which are effectively more specific records and their variable interpretations (e.g. CO_2 over the Phanerozoic, Arctic Ocean drilling, the Palaeocene–Eocene Thermal Maximum, Pliocene warmth). Within each chapter is *c.* 4–6 hours of laboratory, practical or set-problem material. The exercises themselves are varied and range from simple (e.g. descriptions) to more complex (e.g. simple calculations, interpretation). There are exercises that are perfect for the climate module within our first-year geology course, and parts that would be appropriate for our third-year climate options course. The authors have done a tremendous job here, covering a wide range of palaeoclimate applications. They entitle the exercises 'Building Core Knowledge', and this is certainly the case. Any student working through this book would have an excellent understanding of the beauty and challenges in palaeoclimate reconstruction.

The ultimate goal is that a student working through the exercises in this book would then be able to read an article that invoked a palaeoclimate perspective and be able to understand where the data came from and what they actually meant. I think this goal would be achieved if the book is deployed correctly within a university course. Some exercises (e.g. core descriptions) would benefit from higher-resolution images, so lend themselves to problem sets where the students can download or view better images online (the links are provided). My only criticism is that it would have been useful to have more quantitative or 'stretch' problems for students at the Masters level or for course that are overall more quantitative. This is just a small point however, as *Reconstructing Earth History* is an excellent tool. I look forward to using it in the coming year.

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