

BOOK REVIEW

Book Review: Petrochronology: Methods and Applications, RIMG Volume 83. Edited by Matthew J. Kohn, Martin Engi, and Pierre Lanari. (2017) Reviews in Mineralogy and Geochemistry, Mineralogical Society of America, Chantilly, Virginia. 575 p. ISBN 978-0-939950-05-8.

As a community, geologists no longer simply date rocks; they calculate the timing and rates of geological processes. *Reviews in Mineralogy and Geochemistry, Volume 83, Petrochronology: Methods and Applications* summarizes current perspectives on the geological significance of radiometric dates obtained from different isotope systems in the most commonly dated minerals (zircon, baddeleyite, monazite, xenotime, apatite, allanite, titanite, rutile, and garnet).

Over the last two decades, considerable analytical innovations and shifts in paradigms on accessory phase growth and stability have led to the emergence of a new branch of geochronology: *petrochronology*. In 1997, Fraser, Ellis, and Eggins (*Geology*, vol. 25, p. 607–610) used the term *petrochronology* to describe phase equilibria calculations involving zirconium as a method for determining when zircon grew during metamorphism (**petrology + U–Pb chronology**). With increased use of LA-ICP-MS in the 2000s, *petrochronology* has commonly been used to refer to the acquisition of (most commonly) U/Th–Pb dates with other geochemical information (e.g., Hf isotopes, REE, or Ti in zircon) from the same volume of material to provide petrological context/significance to the dates: pressure–temperature conditions of phase growth, changes in abundance of other phases, or changes in magma source. In modern parlance, *petrochronology* has come to refer to any combination of radiometric dates (-chronology) with other petrologically relevant data (petro-) to test hypotheses about the dynamic and thermal processes that affect rocks. Although there has been pushback against the adoption of a new term distinct from the more general term *geochronology*, the existence of this volume of *Reviews in Mineralogy and Geochemistry*—as well as many successful conference sessions and short courses in the past six years—suggests the term *petrochronology* is both useful and here to stay. In the first chapter, editors Engi, Lanari, and Kohn further explain the utility of the term *petrochronology*, providing historical context and discussing its broad importance in modern geological research.

Petrochronology is inherently multidisciplinary, because it is defined by the merging of multiple datasets. A primary strength of this volume is its holistic approach to the topic. Chapters 2 and 3 provide reviews on phase-equilibria calculations and accessory phase stability as a function of pressure, temperature, and bulk-composition. Chapter 4 reviews general processes of diffusion, whereas chapter 16 discusses application of diffusion length scales to calculating rates of magmatic processes (although the principles are more generally applicable). Chapters 5–8 describe

common analytical techniques for measuring elements and isotopes used in *petrochronology*, including the advantages and disadvantages of each technique: electron probe microanalysis (chapter 5), laser ablation-inductively coupled plasma-mass spectrometry (chapter 6), secondary ionization mass spectrometry (chapter 7), and thermal ionization mass spectrometry (chapter 8).

Most important for researchers new to *petrochronology* are the reviews on each of the most commonly dated phases and how dates from those phases are interpreted. Zircon—the most commonly measured *petrochronometer*—is discussed over three chapters: metamorphic zircon (chapter 9), igneous zircon (and baddeleyite; chapter 10), and Hadean zircon (chapter 11). *Petrochronology* of monazite and the other rare-earth *petrochronometers* (xenotime, apatite, and allanite) is discussed in chapter 12. Titanite *petrochronology* is presented in chapter 13, rutile in chapter 14, and garnet—the only rock-forming *petrochronometer*—in chapter 15. Each of these phase-specific chapters not only summarizes existing knowledge, but also provides new perspectives and directions for continued research.

As the rate of scientific publication continues to increase, it can be daunting for students (or even veteran researchers) to dive into a new field of study. The rapidly evolving fields of radiometric dating and accessory phase stability are no different. *Petrochronology: Methods and Applications* provides a much-needed first stop for scientists who are interested in applying modern U/Th–Pb (Lu–Hf or Sm–Nd) dating techniques to their own research, scientists trying to keep up with the continuously growing and changing perspectives on radiometric dating, or the experienced researcher looking for an up-to-date general reference.

