TEACHING GEOCHRONOLOGY AND DEEP TIME PLANETARY HISTORY TO HIGH SCHOOL STUDENTS. M. Rioux[1], T. Blackburn[1], J. Creveling[2], N. McLean[1], R. Buchwaldt[1], S. A. Bowring[1], and R. E. Summons[1], [1]Massacusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Sciences, 77 Massachusetts Ave, Cambridge, MA 02139, [2]Harvard University, Department of Earth and Planetary Sciences, 20 Oxford St., Cambridge, MA 02138.

We are developing a series of teaching modules on Earth history and geochronology for high school students. We emphasize a basic understanding of the principles of radioactive decay based on the two isotopes of uranium, including decay rate, half-life and isotope dilution as a method of atomic book-keeping. This is followed by an introduction how zircons and chondrules act as time capsules and are used to understand the early history of the Earth and moon, and major events in the history of life on Earth.

We divide the approximately four hour module into three parts dealing with both practical and theoretical projects on U-Pb geochronology from meteorites, the moon, the early earth, and major events in earth history. In the first part, we discuss the early history of the solar system through accretion, condensation, and differentiation. Hands-on activities illustrating these concepts include examination of meteorites, rock samples, and zircon crystals. We construct a detailed chronology from condensation to the formation of the oldest rocks on the Earth and moon.

In the second part, we use a curriculum developed for and available on the EARTHTIME website (http://www.earthtime.org/teachingkit.html). The curriculum teaches the science behind uranium-lead dating using tables, graphs, and a geochronology kit. In this module, the students start by exploring the concepts of half-life and exponential decay, and graphically solve the isotopic decay equation. A hands on exercise with double-sided chips labeled with U and Pb isotopes reinforces the concept that radiometric age determinations depend on the Pb/U ratio, not the absolute number of atoms present. Next, we use a simulation of isotope dilution to demonstrate why isotopic ratios, rather than absolute abundances, are used for high precision dating and how this technique can be used to determine accurate dates despite loss of parent and daughter atoms during analysis. An introduction to uncertainty estimation is also included. The chemistry and physics behind geochemical laboratory techniques, ion exchange chromatography and isotope ratio measurements using a mass spectrometer, are explained using models, movies, and posters.

In the final section, students engage in a summary exercise where they apply what they have learned to different problems in earth history. Teachers can choose between three exercises, depending on their interests, and a full day session could include more than one exercise. The first exercise focuses on using U/Pb dating of meteorites and lunar samples to better understand the earliest history of the solar system. In this module, we also introduce the concept of extinct nuclides and show how the presence or absence of a daughter isotope from an extinct short-lived parent provides a window into our nascent solar system. The second is centered on the oldest know earth material, including zircons from the Jack Hills and the Acasta Gneisses, and includes activities with hand samples and microscopes. The third exercise demonstrates how we use geochronology to better understand major events in the history of life, using the end-Permian extinction and possible links with the Siberian Traps as an example.

Additional modules being developed include an exercise on using geochronology to date nodes on the tree of life using both molecular and megascopic body fossils, an exercise on the timing of oxygenation of earth's atmosphere, and an exercise on the Cambrian explosion. We run exercises with teams of graduate students and post-docs who either travel to local high schools or work with students during half-day visits to MIT. The modules are easily adapted to special topics of interest.