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$^{238}U/^{232}Th$ zircon geochronology for the most recent eruptions of El Chichón volcano (Chiapas, Mexico)



**Author**
Pack, Brenda

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Undergraduate

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By

Brenda Pack

Undergraduate

Department of Earth, Planetary, and Space Sciences

**Reflective Essay:**

Although I spent my summer on a two-hour commute taking summer courses both at my hometown and on campus, I still felt the need to challenge myself to gain further insight into geology. As a transfer student, I knew I would need to take the initiative to discover which specific field of geology I wanted to continue my academic path. I visited Dr. Axel K. Schmitt, who taught my Mineralogy and Igneous Petrology courses, to discuss the possibility of conducting my first research. After our discussion, I became interested in researching the magmatic evolution of El Chichón volcano in Chiapas, Mexico.

Not knowing where to begin, I turned to the UCLA Library website. It took some tinkering to navigate through the search engine, but I eventually found several articles on El Chichón volcano through Google Scholar via UC e-links. The library's accessible online catalog made my visits to Science and Engineering Library efficient and worthwhile. I became informed about the various resources that the University provided, from hardbound books, the library catalogue, online databases, WorldCat, and Melvyl.

I was unaware of the amount of time and effort it took to prepare the samples. The first week consisted of crushing pumice, lava, and ash deposits followed by a week's work of rinsing the samples with water and acetone, then sieving them into four fractions. Zircons crystals were then hand picked from 96 and 250 μm and further separated from the non-magnetic and the dense fraction after immersion in methylene iodine. For each sample, 12 to 15 individual grains were hand-picked and placed in rows onto an adhesive tape to make a mount for analysis.

Cathodoluminescence images were acquired using a scanning electron microscope. After imaging, the mount was cleaned and Au-coating was applied to the dried mount. U-Th isotope analyses were made using a CAMECA ims1270 ion microprobe. Analysis spots were placed onto the zircon grains based on the internal structure shown by CL images. After secondary ion centering, magnetic field scanning, and drift-corrected intensities were calculated, zircon model ages were determined using (230Th)/(232Th) and (238U)/(232Th) activity ratios in U-Th isochron

diagrams. U-Pb data were acquired after repolishing, with spots occupying around the same domains that yielded secular equilibrium ages for 230Th.

The remaining two weeks of the course consisted of writing my research paper. *Principles of Igneous and Metamorphic Petrology* and *Introduction to Mineralogy* from the SEL Geology Building assisted me in determining optical properties of zircons and understanding the evolution of the magma reservoir inside El Chichón. *Introduction to Mineralogy* helped me to identify the zircon's distinctive equant shape and strong relief, and understand how crucial the mineral is as a geochronometer. Once zircons become crystallized, uranium would decay to thorium. Generalized information about the geologic background of El Chichón came from Melvyl, such as "Prehistoric eruptive activity of El Chichón volcano, Mexico" and "Magma Mixing, Recharge and Eruption Histories in Plagioclase Phenocrysts from El Chichón Volcano, Mexico" via WorldCat. I narrowed my search results to these two sources because they were most relevant to what I was studying. They showed that the 1982 eruption of El Chichón was one of the deadliest in the 20$^{th}$ century, and its origin was caused by extension leading to decompression melting from the subduction of the Yucatan plate. Furthermore, the active volcano is now comprised of a trachyandesitic Holocene tuff cone and lava dome complex. The papers that Professor Schmitt gave me provided information to understand more about the composition of El Chichón volcano and stratigraphy based on previous studies. I was able to follow the citation tutorial via the UCLA Library Research Guides to cite my sources accurately.

Although the research was just for a quarter, I have continued with the project and am currently producing a manuscript. The directed research course has broadened my knowledge in geology, specifically in geochronology. It was an experience that widened my scope and appreciation of the field of research, because I applied the theoreticals and information to the actual and physical work and see, firsthand, how dating the zircons can yield a lot more information than just their age. This continuing journey of online databases and laboratory work has given me certainty and the conviction that I want to continue my academic career in research. This project has definitely been

worthwhile and inspires me to pursue further research topics that pertain to geochemistry from the invaluable help of Professor Schmitt, and the online database of journals and books from the SEL and UCLA Library.

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**BRENDA PACK*,** Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, California 90095-1567, U.S.A.

*bpack@ucla.edu

**ABSTRACT**

El Chichón is the only active volcano within the Chiapanecan Volcanic Arc, Southern Mexico, which is located between the Trans-Mexican Volcanic Belt and the Central America Volcanic Arc. Remote sensing, fieldwork, geochronology, and petrology studies have shown that at least 11 eruptions have occurred in El Chichón within the last 8000 years, forming a complex of lava domes with a central crater and surrounding pyroclastic deposits. This paper contributes to a new understanding of El Chichón's eruptive history and magmatic evolution through dating crystallization ages of zircon, which originate within the intrusive complex underneath the volcano. Zircon dating focused on the most recent eruption of 1982 and the antecedent AD 1450 eruption. U-Th disequilibrium zircon ages range from 9.3±2.7 ka to 734+∞/-511 ka in composite pumice samples from a pyroclastic flow and lava from an intracrater dome (errors 1σ; ∞ indicating secular equilibrium). Overlapping U-Th zircon ages between 5.8+4.7/-4.5 ka and secular equilibrium were obtained for a composite pumice sample from the AD 1450 eruption. Because many older ages overlap within uncertainty with secular equilibrium for $^{230}Th/^{238}U$, reconnaissance U-Pb dating was performed of the same crystals. The U-Pb ages range between ca. 290 Ma and 1.2 Ga and indicate xenocrystic origins for these crystal domains. This is the first evidence for zircon recycling from crustal rocks, and the generation of young zircon crystals and overgrowths in a long-lived magma system underneath El Chichón. This new application of zircon dating for El Chichón determines ages of zircon crystallization in a subterranean magma reservoir, which significantly predates what is recorded in eruptive stratigraphy.