High-resolution dating of seafloor basalt with uranium-series isotopes

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More intensive study of mid-ocean ridge processes has led to a growing need for accurate and precise methods for dating ocean ridge basalts. Eruption ages are required to understand fundamental issues relating to ocean crust formation, such as the spatial extent of volcanism at the axes of ocean ridges. Development of mass spectrometric measurement techniques for the long-lived uranium-series decay systems (^{238}U-^{230}Th,^{235}U-^{231}Pa, and ^{230}Th-^{226}Ra) has allowed the successful application of chronometers for ocean basalts with eruption ages ranging from 0.1-350 ka. For example, combined ^{230}Th and ^{231}Pa age dating was used to study the recent volcanic evolution of a ridge segment at 9°31'N East Pacific Rise, including samples from ODP Leg 142, which drilled two holes at the axis [*Goldstein et al.,* 1994]. U-series ages for basalts on the crestal plateau, away from the axial summit caldera, were found to be anomalously young compared to ages based on spreading rates. The age anomalies and the distinct composition of these samples suggest that most of these basalts were erupted 0.5 to 2 km outside the axial summit caldera, and that some volcanism occurs as far as 4 km off-axis. From these results and earlier dating at Juan de Fuca Ridge [*Goldstein et al.,* 1992], it appears that eruptions outside the zone of focused axial volcanism may be common, and that the magmatically active zone at intermediate and fast-spreading ridges is much wider (~x20) than previously assumed. This has important implications for the way in which oceanic crust is formed. Future work will extend these detailed studies to different ocean ridge environments, such as slow spreading ridges or areas of robust magmatism, and better define the relative advantages and limitations of the different dating techniques applicable to studies of ocean ridges.

References:
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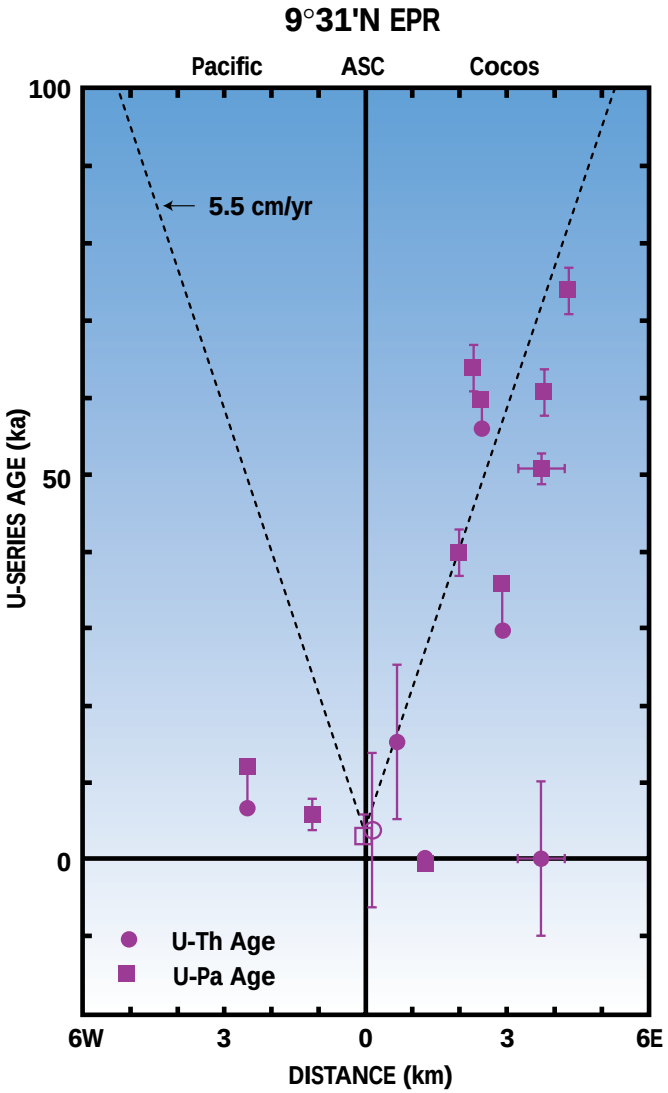

^{230}Th and ^{231}Pa ages vs distance off-axis for 9°31'N East Pacific Rise, after Goldstein et al. [1994]. Anomalously young ages for most samples relative to paleomagnetic spreading rate (dashed line) indicate that the neovol-canic zone is quite expansive (~4-8 km wide) relative to the width of the axial summit caldera (~200 m).