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Preface

Dating Quaternary sediments and landforms in Drylands

Quaternary arid-land geochronology has always been challenging. The scarcity of preserved material suitable for radiocarbon dating is a substantial hurdle. However, attempts to overcome this difficulty have led to the rapid development of a number of geochronological techniques, such as terrestrial cosmogenic radionuclide surface exposure, U-series, and luminescence dating, which are well suited for arid environments. The subsequent rise and fall of rock varnish methods as a reliable geochronometer has led Quaternary geologists in arid regions to be exceptionally diligent as well as skeptical (Dorn, 1988; Beck et al., 1998; Watchman, 2000).

With this background, the INQUA Dryland Dating Subcommission convened its first 3-day workshop in March 2005 with the goal of searching for geological sites, where Quaternary geochronologic methods may be tested and compared, and to share knowledge among researchers in the field. Emphasis was placed on presenting and testing new methodologies. Furthermore, the meeting aimed to stimulate interlaboratory comparisons of dating undertaken on sediments and landforms in drylands. Another objective of the workshop was to involve students, so that they become familiar with the challenges and possibilities of geochronology in arid environments. The site of the workshop was at the Desert Study Center in Zzyzx in the Mojave Desert of California. Located near the center of the Mojave Desert, Zzyzx offers proximity to well-chronicled pluvial lake (e.g., Jefferson, 2003; Wells et al., 2003) and classic alluvial fans (e.g., Denny, 1965; Hunt and Mabey, 1966) localities. The workshop included approximately 20 participants from the USA, Canada, UK, and Mexico.

Major points of agreement at the workshop include:

(1) Wherever and whenever possible, multiple dating methods should be employed in arid-land geochronologic, geomorphic, and geologic studies.
(2) Whenever and wherever possible, if only one dating method is being used than multiple samples in a stratigraphic sequence should be collected and analyzed.
(3) Key sites need be identified in drylands where multiple numerical chronometric techniques can be applied to test the validity of basic assumptions for each of the dating methods to enable a synergistic use of data from each method to be undertaken.

At the meeting it was recognized that budgets do not always allow the use of multiple methods. However, perhaps just as frequently, there may be a reliance on the familiar or the easily accessible dating method, or a fear that the two methods may not corroborate each other, or a lack of knowledge of the rapid advancements in various dating methods. To overcome these problems, the delegates discussed collaboration and means of educating the community in the application and testing the validity of the various methods available to date sediments and landforms in drylands. This volume is our first attempt at highlighting some of the successes and problems of applying many of the newly developed and well-established geochronological methods. Furthermore, the meeting provided an assessment of the first likely key site, at Silver Lake, where multiple dating techniques could be applied and where future research would have easy access to re-evaluate several different dating methods. This site is described in Owen et al. (this volume). A summary of the optimal conditions for a key site where multiple geochronologic methods would be available and utilized multiple times in the stratigraphic sequence was developed after discussions at the meeting and examination of the Silver Lake site. This is summarized in Fig. 1. In reality, finding such a site is a challenge, but it is hoped that the Quaternary geology and geochronology community will strive to recognize such sites for future study.

This volume comprises eight papers, which illustrate the diversity of methods and geographic range of studies being undertaken in Drylands. The first two papers, Pigati et al. and Maher et al., present new and innovative methodological approaches. The former provides details regarding the assembling and testing of a vacuum extraction line suitable for analysis of 40–60 ka radiocarbon samples. They have overcome the low-sample activity problems with these older samples and have utilized entirely "off-the-shelf" parts for assembly. Their paper represents a model for laboratories anticipating construction of such a facility. Maher et al.'s paper uses ion-microprobe techniques to date, using U/TH methods, silica-rich pebble coatings from pedogenic carbonate horizons, a siliceous sinter deposit, and opaline silica deposited as a spring mound. The approach enables a microstratigraphy to be obtained for each deposit resulting

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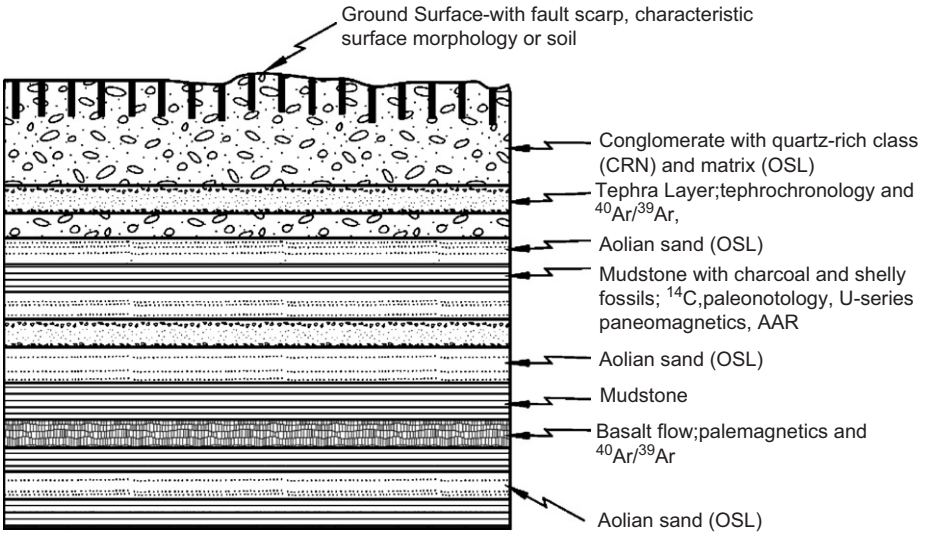

Fig. 1. Geochronologically "optimal" Quaternary arid-land site showing various materials and dating methods suitable for each lithology, including amino-acid racemization (AAR).

in better accuracy in the age determination for finely layered or complex deposits.

The next series of papers apply optically stimulated luminescence (OSL) dating. The first, by Chase and Thomas, utilizes OSL methods at multiple sites along the African west coast. They identify five distinct Quaternary dune-forming periods in the stratigraphic record. After comparison with the marine climate record, they infer that wind strength and sediment supply are critical factors in coastal dune formation. Twidale et al. follow this by presenting preliminary OSL results of inland dune formation in Australia. In this region, they infer three periods of dune formation, including historic dune activity. The next two papers, Sohn et al. and Mahan et al., show the application of OSL methods to sites in the SW USA. Sohn et al. present the first comprehensive OSL study for sediments within Death Valley, providing ages on alluvial fan sediments to test the connections between climate, tectonics, and landscape development. Mahan et al.'s paper provides some of the first dates on groundwater deposits and highlights the diversity of sediments that may be dating using OSL methods.

The next paper in the volume, by Knott et al; provides an analysis of minor and trace elements within volcanic glass shards that occur in the SW USA using solution inductively coupled plasma-mass spectrometry. The authors use these results to date the deposits using tephrochronological methods.

The last paper in the volume, by Owen et al., provides an example of a site that might be considered as a test for a key location to compare dating methods. This is an extensive field test of different geochronological methods and multiple laboratories at a well-documented pluvial lake site in the Mojave Desert. Their study shows the possible conflicts that may arise from using multiple dating methods as well as the diligence that must be used when interpreting the results. This type of application should be considered as a model for Quaternary geologists wishing to confirm their geochronologic methods.

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