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ARTIFACTS AND FEATURES
OBSIDIAN HYDRATION DATING

This article is one of an occasional series discussing matters archaeological, especially with reference to the Maturango Museum. In previous articles we have talked about why chronologies are important in archaeology, and about a few qualitative techniques for establishing dates or sequences. Subsequently we started discussing quantitative chronological techniques, specifically dendrochronology (tree-ring dating) and radiocarbon. Today we will briefly cover obsidian hydration dating (OHD), a widely-used technique, which was first proposed in 1960 by Friedman and Smith of the US Geologic Survey.

Obsidian is a rhyolite glass, resulting from rapid cooling of molten lava. When a surface of obsidian is flaked it is immediately exposed to atmospheric water vapor, and water molecules diffuse into the obsidian glass at a predictable rate. As the water diffuses into the glass it causes a change in refractive index in the hydrated layer. If a small cross-sectional sample is cut from the obsidian, mounted on a microscope slide, and polished to transparency, the interface between hydrated and unhydrated volumes (the "hydration front") can be observed under a polarizing microscope. The hydrated volume is referred to as the hydration rim, and its thickness in most archaeological cases is of the order of microns. If the rate of hydration is known or can be inferred, the time since the surface was flaked can be estimated. Thus OHD holds promise of being able to estimate directly when an artifact was created.

The rate of hydration is dependent on the obsidian chemistry, the intrinsic water content of the glass, temperature and relative humidity, and the chemistry of the diffusing water. Generally, the age of an artifact is approximately proportional to the square of the rim thickness, although other relationships are sometimes derived for specific cases. Typically the rate is determined by correlating artifacts of known rim thickness with other chronological data such as radiocarbon. Attempts have been made to measure the hydration rate directly in the laboratory, but, with a few exceptions, results have generally been poor. Also, other methods than optical microscopy have been explored for measuring rim thickness, but none are in general use and all must be regarded as experimental at present.

The optical OHD technique is simple and cheap - about $17 for each sample, plus about $20 for the chemistry analysis (about one tenth the cost of radiocarbon) - and is thus very popular. It is especially useful in the deserts and the Great Basin, where obsidian artifacts are frequently recovered, but few samples suitable for radiocarbon or dendrochronology dating are found.

As always, things are never as simple as they seem. The hydration rate is dependent on obsidian chemistry, and hence on the source of the obsidian, since the trace element content varies from flow to flow; for example, obsidian from Sugarloaf Mountain at Coso is a relatively fast obsidian, whereas other sources are slow. Therefore the hydration rate is specific to the source. Perhaps the biggest problem is temperature, since the hydration process is strongly temperature-dependent and the temperature history of an artifact can never be completely known. There are mathematical techniques to compensate approximately for temperature effects, but they are still a major source of uncertainty. Furthermore, heat sources such as forest fires can affect the results of the

OHD process. It is generally good practice to measure a large number of samples so statistical techniques can be employed.

Since OHD is dependent on processes which have occurred since an artifact was created, it can never be as accurate and reliable as radiocarbon or dendrochronology, and it should be always a secondary source of chronological data. In this respect it is similar to techniques such as pottery seriation, which we discussed in previous articles; it gives useful data, and sometimes may be the sole source of chronology, but it should always be treated with caution. Similarly, since the inferred ages are subject to so many variables, it is important always to report the actual micron readings obtained from the samples, so other researchers can apply their own judgment. These problems are manageable, however, and the technique continues to be a very valuable tool for archaeology.

In the next article we will briefly review the dating techniques which have been applied (or attempted to be applied) to petroglyphs.