

Analysis of Modern and Ancient Artifacts for the Presence of Corn Beer; Dynamic Headspace Testing of Pottery Sherds from Mexico and New Mexico

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1. Introduction

Sandia's **Materials Characterization Department** employs a variety of tools to support research for both internal and external customers. Initially, SNL was asked to perform colorimetric spot tests (1) for *furfural*, a chemical thought to be an indicator for corn fermentation found on archaeological sherds. A more complex but potentially more information-rich technique was proposed and performed using “modern” equivalents and real archaeological samples.

2. Hypotheses

Archaeologically, did historic cultures of the American Southwest have fermentation practices that pre-date the European conquest of the New World? With respect to chemical analysis; can volatile and/or organic compounds be detected from sherds, and is it possible to detect marker compounds that indicate a fermented beverage.

3. Methods

Volatile chemicals were released, separated, and detected using TD/GC/MS (Thermal desorption / gas chromatography / mass spectrometry).

Advantages: 1. solvents not used, 2. temperature is adjustable, 3. sample retains nonvolatile residues (for other tests), and 4. nondestructive to artifact!

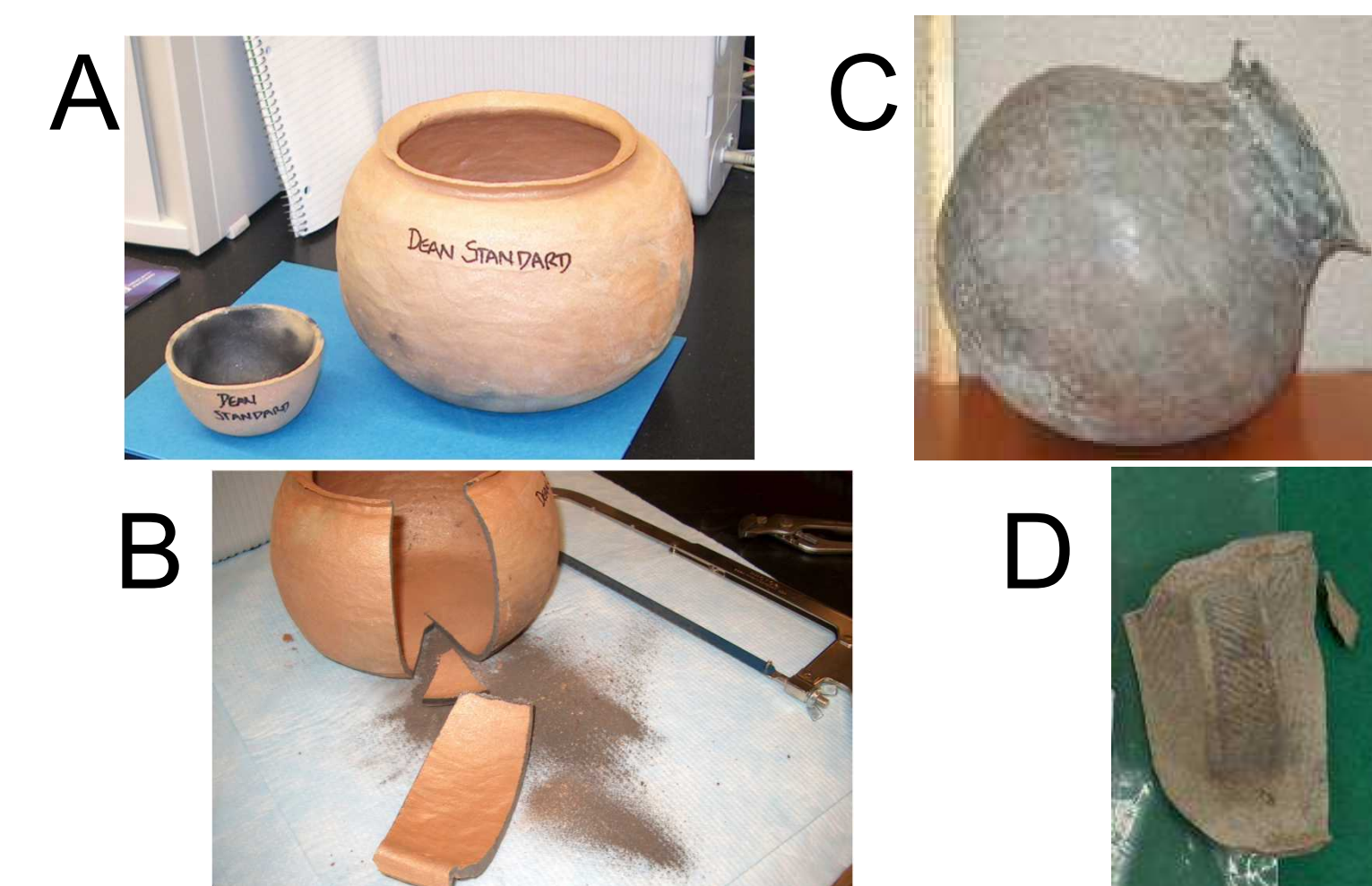


Figure 1. Photos of a modern brew-pot A) in use and B) cut for testing, C) Tarahumara pot and D) an archaeological sherd.

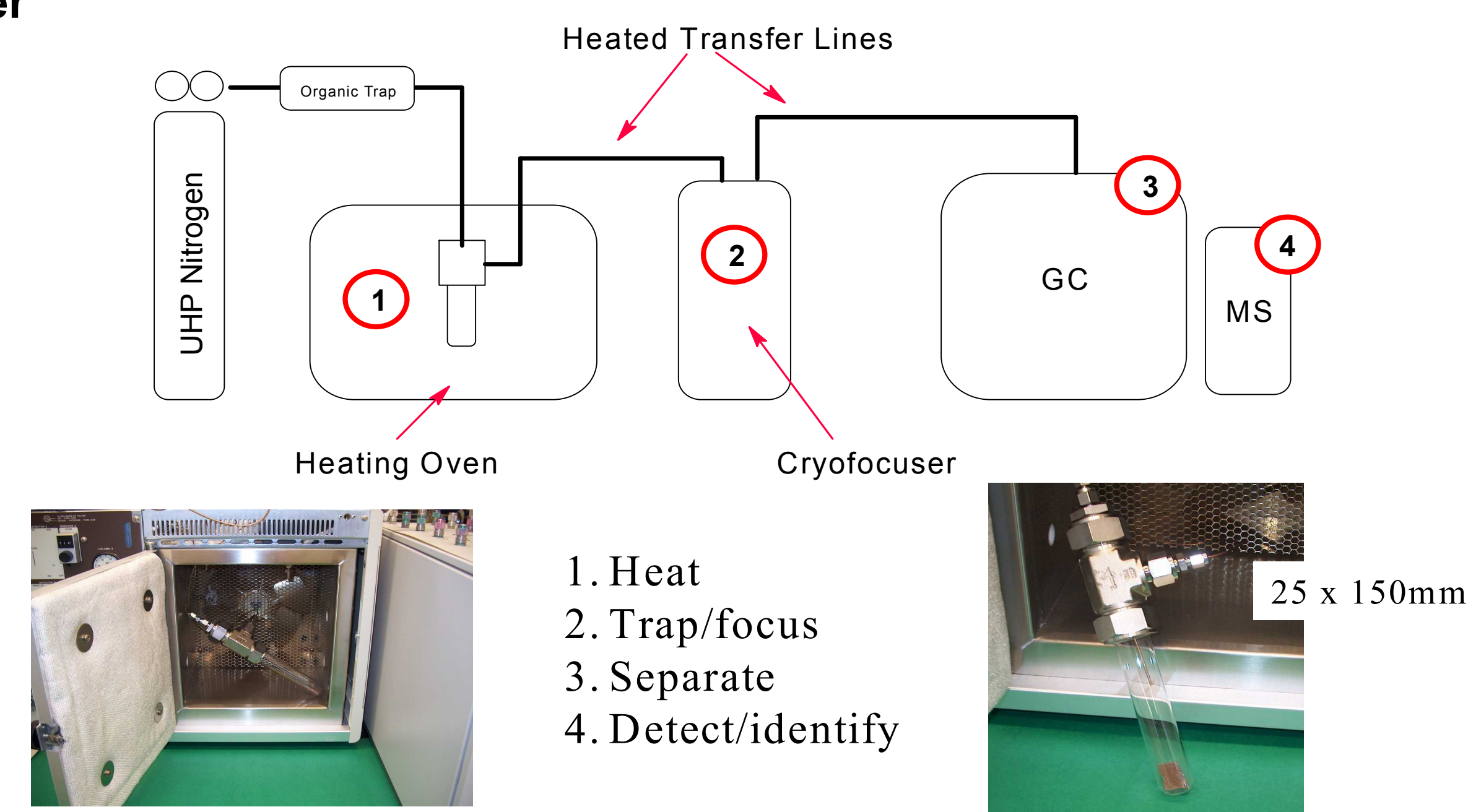


Figure 2. Schematic and photos of dynamic headspace sampling used to collect volatiles from sherds.

4. Results

A variety of modern and archaeological samples have been analyzed:

Modern samples: pots, cups, storage vessels, foodstuffs, soils, and pots from the modern Tarahumara tribe in Mexico.

Archaeological samples: sherds from cylinders, jars, pitchers, and bowls.

More than 400 compounds were detected from some samples, including furfural. More than 100 compounds have been identified (using reference library searching) including hydrocarbons, ketones, aldehydes, and chlorinated hydrocarbons.

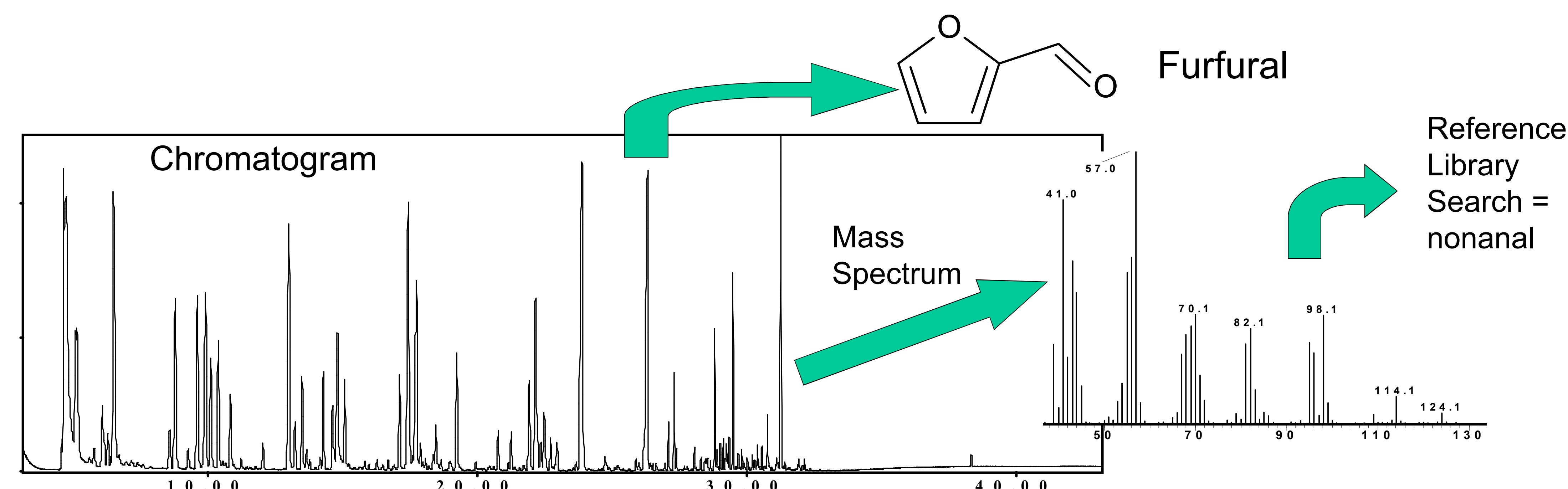


Figure 3. Analysis of modern brew pot, showing chromatogram (separation of compounds desorbed from sherd), and mass spectrum of one peak used for identification.

5. Results (cont.)

Figure 5 shows examples of some of the compounds identified.

Furfural was detected in:
11/37 archaeological samples,
7/8 Tarahumara sherds,
Squash, corn, rice grass, and wheat samples,
Many of the modern brew vessels.

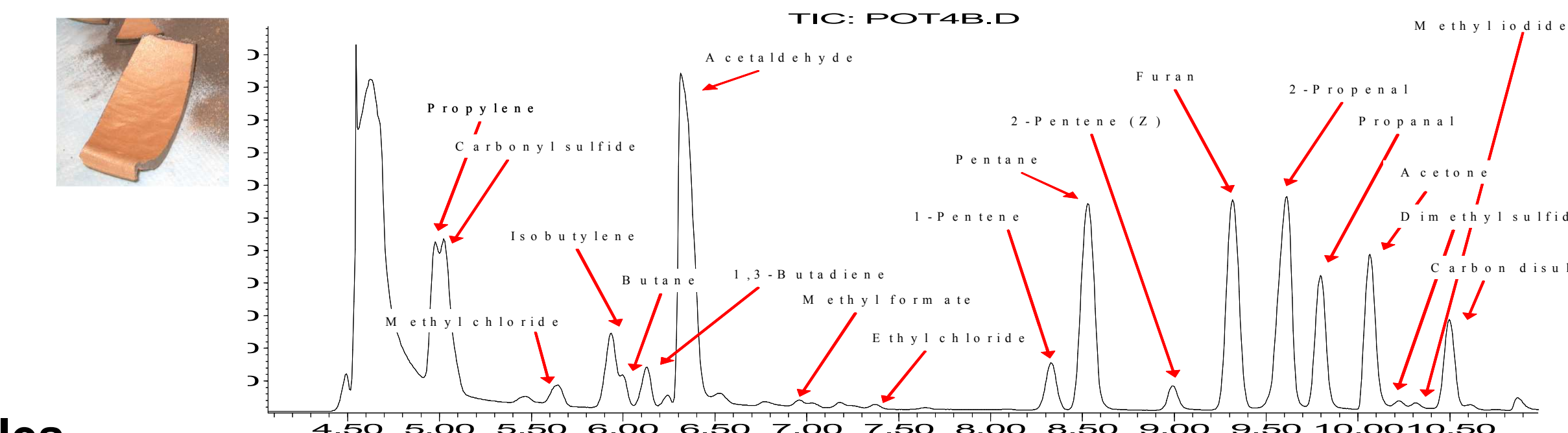
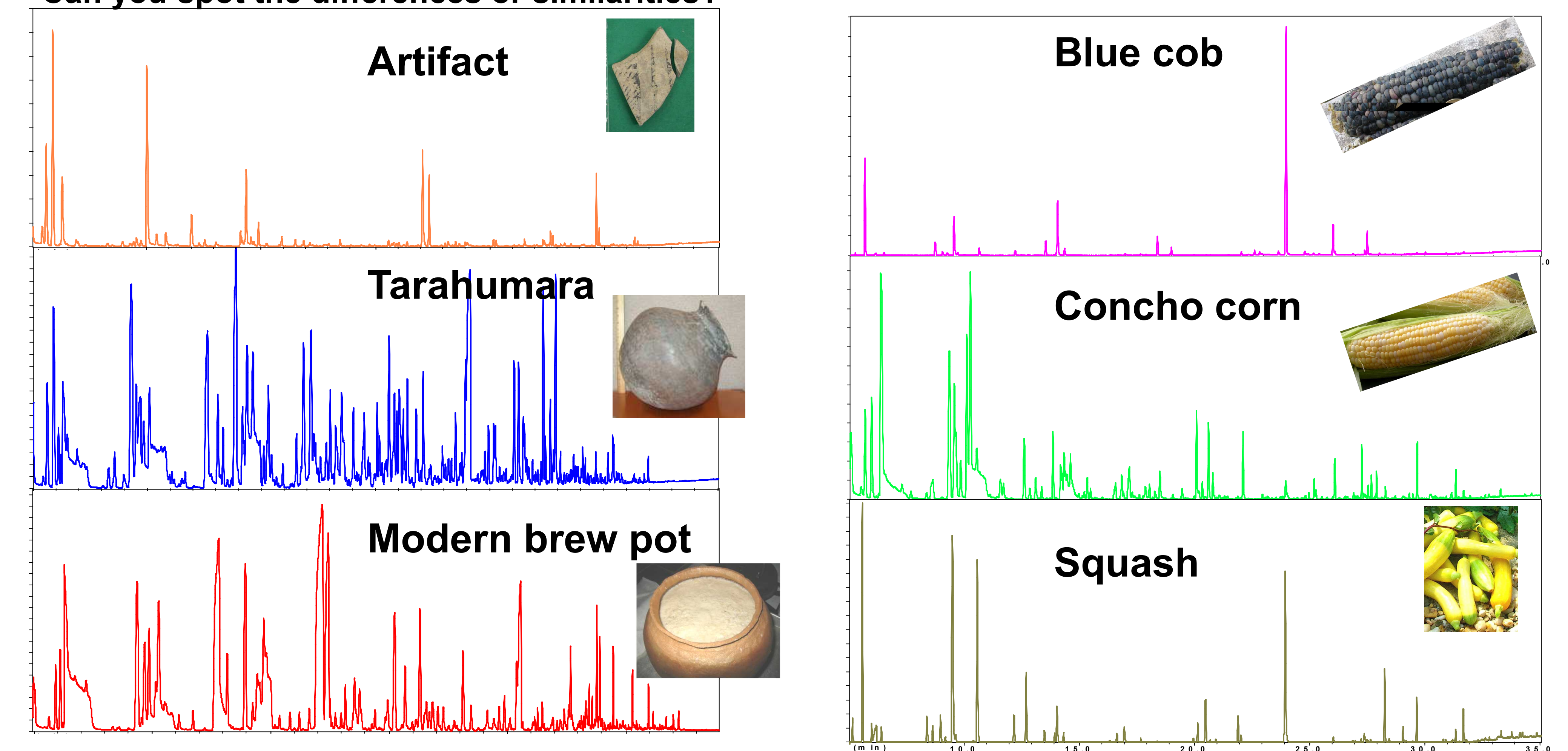
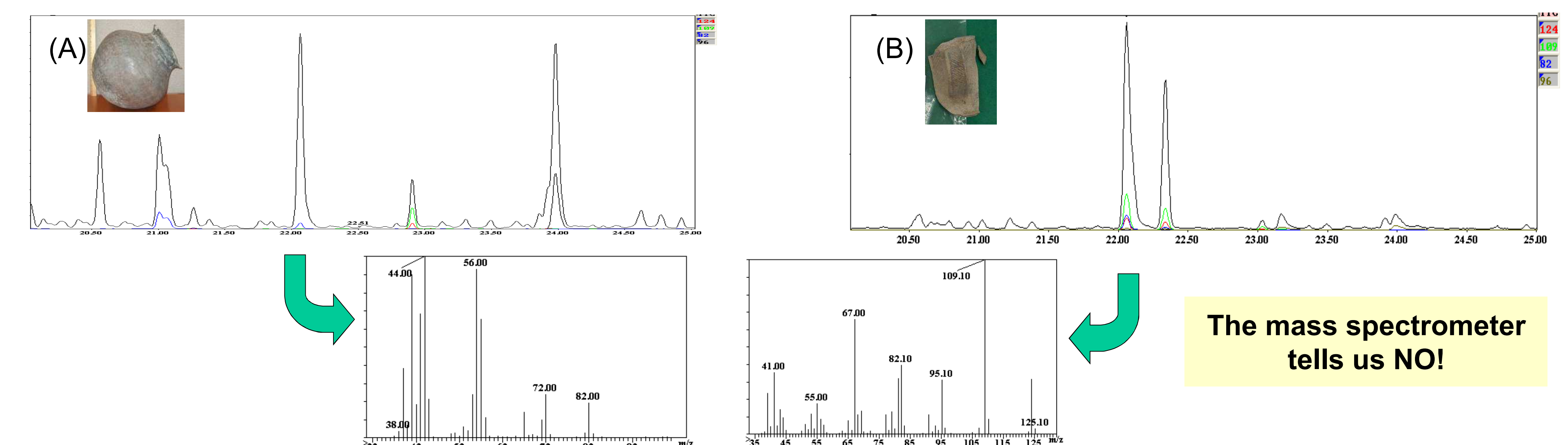


Figure 4: Peaks identified for modern brew pot.

Can you spot the differences or similarities?



Both Tarahumara (A) and Artifact (B) have a peak at 22.0 min. retention – are they the same compound?



3. Conclusions

The dynamic headspace sampling technique allows signature compounds to be detected **nondestructively** and for other volatile compounds to be **detected and identified** from both modern and archaeological pottery. Furfural was detected in artifacts, Tarahumara pots, modern pots, and foods. There appear to be consistencies across the modern brewing and Tarahumara pots and additional comparisons are ongoing.

References:

1. Anger and Ofri, 1964