An Introduction to Archaeological Chemistry

Technical Information

This section is intended for technical things, information not appropriate in the body of the book, protocols, useful notes, tips, conversions, tables, and the like.

Journals, Books, Conferences

Information about archaeological chemistry is available from a number of different sources. This section lists journals, books, conferences and societies that focus on or include archaeological chemistry. There are two major, international associations (Archaeometry and the Society for Archaeological Science) that meet regularly (Archaeometry and the Society for Archaeological Science) and have associated journals (*Archaeometry* and the *Journal of Archaeological Science*).

Journals

Journal of Archaeological Science
Archaeometry
International Journal of Human Osteology
American Antiquity
Geoarchaeology
Journal of Field Archaeology

Books, Reports, Newsletters

Archaeological Chemistry, vols. 1–5 (American Chemical Society)
Ceramics and Civilization, vols. 1–4 (American Chemical Society, with various editors, beginning 1974)

Materials Issues in Art and Archaeology, vols. 1–7 (Materials Research Society)

MASCA Research Reports (Museum of the University of Pennsylvania)

SAS Bulletin (Society for Archaeological Sciences)

Scientific Conferences

Meetings, symposia, and conferences are important parts of a scientist's calendar. Archaeological chemists and archaeometrists hold regularly scheduled conferences to get together and present new methods and results and to socialize. Such conferences are important for the field so that information is quickly shared and so that the participants can meet each other. Such meetings often result in collaborative research and new ideas, as well as more personal relationships among the participants. An *Archaeometry* meeting takes place every 2 years in different parts of the world. The meeting lasts for 5 days and covers a wide range of topics through oral presentations and posters sessions. The *Society for Archaeological Sciences* meets every year at different venues and hosts symposiums. The *American Chemical Society* often holds a special session for archaeological chemistry at its annual meetings. In addition, many smaller, more specialized conferences on specific aspects of archaeological chemistry and archaeometry take place frequently. These are usually more intense discussions of a focus topic intended to exchange information and ideas and to work toward new approaches to problems. All these conferences share common goals of increasing information flow, research efficiency, and knowledge.

Weights and Measures

Most people when faced with very small, or large, numbers have little idea of the size involved. The following examples may help understand what these numbers mean.

If you wanted a very dry martini, you might make a recipe of five parts per million (5 PPM) vermouth in your favorite gin. What would it take to mix this drink? *PPM* parts per million, *PPB* parts per billion, *PPT* parts per trillion.

Dry martini recipes

5 PPM $\Rightarrow$ 1 oz. vermouth + 1,562.5 Gallons of Gin
This is enough Gin to fill a party size hot tub $10 \times 10 \times 2$ ft

5 PPB $\Rightarrow$ 1 oz. vermouth + 1,562,500 Gallons of Gin
This is the equivalent of a very large swimming pool $100 \times 200 \times 10$ ft

5 PPT $\Rightarrow$ 1 oz. vermouth + 1,562,500,000 Gallons of Gin
This is the equivalent of the flow of the Mississippi River for about 6 h.

Equivalents for several important measures are given below.

Kilogram (kilo, kg) – kilo means 1,000, there are 1,000 g in a kilogram. A cube of water 10 cm on a side is 1 l (10 cm^3) and weighs 1 kg.

Gram (gm, g) – A gram is 1/1,000th of a kilogram and equal to the weight of water in a cube 1 cm on a side (1 cm^3).

Milligram (mg, mgs) – Milli means 1/1,000 and 1 mg is 0.001 g, or 1,000 mg = 1 g. A milliliter is 1/1,000th of a liter. A cubic centimeter of water is a milliliter (usually abbreviated as cc).

Microgram (μg, μgs) – Micro means 1,000,000th, so 1 μg = 0.001 mg, or 1,000 μg = 1 mg, or 1,000,000 μg = 1 g. A microliter is 1/1,000,000th of a liter.

Volume measure

10 milliliters (ml)=	1 centiliter (cl)	
10 centiliters=	1 decliliter (dl)	=100 milliliters
10 decliliters=	1 liter (l)	=1,000 milliliters
10 liters=	1 dekaliter (dal)	
10 dekaliters=	1 hectoliter (hl)	=100 liters
10 hectoliters=	1 kiloliter (kl)	=1,000 liters

Cubic measure

1,000 cubic milliliters (mm^3)=	1 cu centimeter (cm^3)
1,000 cubic centimeters=	1 cu decimeter (dm^3)
=	1,000,000 cu millimeters
1,000 cubic decimeters=	1 cu meter (m^3)
=	1 stere
=	1,000,000 cu centimeters
=	1,000,000,000 cu millimeters

Weight

10 milligrams (mg)=	1 centigram (cg)	
10 centigrams=	1 decligram (dg)	=100 milligrams
10 decligrams=	1 gram (g)	=1,000 milligrams
10 grams=	1 dekagram (dag)	
10 dekagrams=	1 hectogram (hg)	=100 grams
10 hectograms=	1 kilogram (kg)	=1,000 grams
1,000 kilograms=	1 metric ton (t)	

Glossary

Absolute dating Method of dating can provide an age in calendar years.

Accelerator mass spectrometer (AMS) A huge scientific instrument used for sorting and counting isotopes. AMS dating allows much smaller samples to be used in archaeology.

Accuracy The ability of an instrument to provide the correct answer.

Activity area Location of specific tasks or behaviors within a site.

Additive technique Manufacture of an object involves making a bigger item from smaller pieces; example pottery or house building.

Adobe A brick made of earth and straw and dried by the sun.

Agriculture Subsistence practice based on the cultivation of domesticated plants and/or the herding of domesticated animals.

Aliquot An equal, measurable part of a large whole.

Amino acid Simple organic compounds containing carbon, hydrogen, oxygen, nitrogen, and in certain cases sulfur. Twenty amino acids are the building blocks of proteins.

Analysis The search for information and pattern in archaeological materials.

Ancient DNA (aDNA) Genetic material preserved in archaeological or paleontological plant, animal, or human remains.

Anthropogenic Created or produced by human activity, e.g., anthropogenic soils are a result of human activity.

Anthropological archaeology Archaeological investigations that seek to answer the larger, fundamental questions about humans and human behavior taught in departments of anthropology.

Apatite The mineral part of bone and tooth enamel, $Ca_{10}(PO_4)_6(OH)_2$.

Appendicular skeleton The limbs (the clavicles, scapulae, bones of the pelvis, and the upper and lower limbs, including the hands and feet).

Arboreal pollen (AP) Pollen from trees.

Archaeobotany (aka paleobotany, paleoethnobotany) The study of archaeological plant remains.

Archaeological chemistry The investigation of inorganic and organic composition, elements and isotopes, molecules and compounds in archaeological materials.

Archaeological context The buried or surface context in which archaeological remains are found; what survives to the present.

Archaeological culture A group of related materials from a region that indicate a common or shared way of doing things.

Archaeological record The body of information about the past that has survived to the present.

Archaeological science A generic term that includes non-instrumental areas such as faunal analysis, paleoethnobotany, and human osteology.

Archaeology The study of our human past, combining the themes of time and change, using the material remains that have survived.

Archaeometry The measurement of the chemical or physical properties of an artifact in order to solve problems of chemical composition, technology, chronology, etc. Sometimes described as "instrumental" archaeology.

Archaeozoology The study of animal remains in archaeology.

Articular The portion of the bone that touches another bone, usually a surface at the end or edge of a bone.

Artifacts Any object or item created or modified by human action; the objects and materials that people have made and used.

Atomic mass The total number of protons and neutrons in a single atom, often expressed in unified atomic mass units (AMU).

Atomic number The number of protons in the nucleus of an atom, distinctive for each element.

Atomic weight The average atomic mass for the different isotopes of an element, weighted by the abundance of each isotope.

Attributes Detailed characteristics of archaeological materials and information.

Base The lower part of a ceramic vessel.

Bifacial A term describing a flaked stone tool in which both faces or sides are retouched to make a thinner tool. See also "Unifacial."

Bioarchaeology The study of human remains from archaeological contexts.

Biological anthropology The study of the biological nature of our nearest relatives and ourselves.

Body sherd Fragment of broken pottery that do not include the rim of the vessel.

Bronze A mixture of tin (or arsenic) and copper that produced a harder metal. Produced in both the Old and New Worlds.

Bundle burial A disarticulated group of bones buried in a group, probably tied in a bundle or wrapped in a skin or cloth.

Burial population The set of human remains found interred in a site or cemetery.

Calibration Correction of radiocarbon dates for the difference between calendar years and radiocarbon years.

Cementum annuli Annual deposits of cementum around the base of teeth.

Ceramic Fired clay.

Ceramic petrography Microscopic technique for study of the mineral composition of pottery.

Chelating agent Used in chemistry to form multiple bonds with a single metal ion and can be used to mobilize metals such as obtaining lead samples from ceramics, metals, and glass. Chelates are used in medicine to remove heavy metals, such as lead or mercury, from the bloodstream.

Chert A cryptocrystalline quartz with sub-microscopic crystal size and impurities that give it color and cloudiness.

Chromatograph A spectrum of the amount of the various molecules present in a sample.

Chronology A framework of time to show the order of events, a dated sequence of events in the past.

Civilization A generic term for state-level societies that refers to the presence of characteristics such as monumental architecture, writing, stratified social organization, and large population.

CN analyzer Instrument used in archaeology to measure carbon and nitrogen abundance in organic materials.

Collagen The protein that makes up the organic portion of bone.

Composition The mineral and organic contents in a petrographic thin section.

Compounds Combinations of elements in either organic or inorganic molecules.

Conservation Preservation and restoration of archaeological materials in the laboratory and museum.

Context Place and association among the archaeological materials and the situation in which they occur.

Correlation A measure of association between two sets of numbers.

Cortical bone Hard, dense bone tissue commonly found in limbs and supporting structure of the skeleton.

Crystalline Materials with atoms arranged in a regular geometric pattern, used in XRD analysis.

Culture (1) Learned human behavior; (2) human societies or ethnic groups.

Data Information collected in a study, including numbers, text and/or images; the observations and measurements of archaeological materials.

Deciduous teeth The first set of "baby" teeth that are lost when the permanent teeth erupt.

Dendrochronology A dating technique used in archaeology to date old pieces of wood, based on the principle of annual growth rings in trees.

Descriptive statistics Used to summarize information and for the comparison of numbers in different sets of data; mean, median, mode, range, variance, standard deviation are descriptive statistics.

Diachronic Dealing with change over time, comparing two or more time periods.

Diagenesis Post-depositional contamination of materials, chemical changes in artifacts.

Diatom Silicate shells of microscopic algae.

Dichroic (two-color) A translucent material of two colors depending on the direction of the light.

Diffraction Principle of X-rays being scattered when striking a crystal, used in X-ray diffraction analyses.

Diffusion The spread of new ideas or materials from one group to another.

Discriminant analysis Statistical technique for classifying a set of observations into predefined classes based on new measurement.

Division of labor Individuals, groups, or segments of society perform different activities.

Ecofacts Unmodified, natural items found in archaeological contexts, often plant or animal material.

Economy The means and methods that society uses to obtain food, water, and resources for maintenance and growth.

Electromagnetic spectrum The wavelength or energy range of all possible electromagnetic radiation.

Element Building blocks of matter, different atoms by atomic number.

Environment The natural and social milieu in which human societies operate.

Enzyme A protein that catalyzes a chemical reaction.

Epiphysis Joint ends of bones where growth occurs.

Ethnoarchaeology Study of living societies of information on the past.

Evolution Generally accepted explanation for the development of life on earth.

Excavation The exposure, recording, and recovery of buried materials from the past.

Exotic Foreign, unusual, in archaeology refers to artifacts and other materials from non-local sources.

Fabric The geometric relationship of the constituents in a petrographic thin section.

Faience Non-clay based ceramic, made from sand, salt (natron), calcite lime, and various mineral pigments, displaying surface vitrification which results a bright luster.

Fatty acid Organic compound in animal and vegetable fats and oils. A straight chain hydrocarbon with a carboxylic acid (–COOH) group at one end, which reacts with glycerol ($C_3H_5(OH)_3$) to make a fat.

Fauna Generic term for the archaeological remains of animals; the category of animals.

Faunal remains The animal ecofacts found in archaeological contexts, including bone, teeth, antler, ivory, shell, scales, and the like.

Features The permanent facilities and structures that people construct in or on the earth.

Fieldwork An important part of archaeological research involves survey for and excavation of archaeological materials, practices normally done outdoors (in the field) and collectively known as fieldwork.

Fill Geomorphological terms for deposition of sediments, also human filling.

Flake A type of stone artifact produced by removing a piece from a core by chipping or knapping. Flakes are made into a variety of different kinds of tools or used for their sharp edges (without further retouching).

Flint A hard siliceous stone that breaks in predictable ways to produce sharp flakes, common raw material for stone tools in prehistory.

Flora Generic term for the archaeological remains of plants; the category of plants.

Flotation A process to recover charred or burned plant materials by floating them in water.

Fluorine absorption An archaeometric test for relative dating based on the assumption that fluorine accumulates at a constant rate in buried bone.

Fossil The mineralized bone of an extinct animal. Most bones associated with humans in the Pliocene, Pleistocene, and Holocene are too young to have been mineralized, but the term *fossil skull* or *fossil bone* is often used generically in these cases as well.

Fossile directeur (French: indicator fossil) a single fossil species as a marker of a time horizon.

Fractionate Process through which the ratio of isotopes in a material can be changed by heat, photosynthesis, enzymes, or other natural mechanisms.

Fume hood A ventilation system for removal of toxic gas in a chemistry lab.

Function The use of an artifact; the action or activity for which it was made.

Gas chromatograph–mass spectrometer (GC–MS) Archaeometric technique for organic materials, samples in gas state separated in a column and exit sequentially to a detector that produces a spectrum of the weight and amount of the molecules.

Geiger counter A device for measuring radioactive emissions.

Geoarchaeology Archaeological research concerned with geology and the earth sciences.

Geographic information systems (GIS) A computer program(s) for the storage, display, and analysis of geographic and spatial data. The basic concept involves the use of overlaid maps of an area in combination with locational information and spatial analytical capabilities.

Geomorphology The branch of geology concerned with the study of the shape of the land, and involves classification, description, origin, and change of land forms.

Glaze A metallic or glass mixture used to change the surface of the pottery vessel for decorative purposes.

Glow curve In thermoluminescence, a graph of the amount of light emitted with temperature for a specific mineral.

Hieroglyph originally, the pictographic script of ancient Egypt; any depictive, art-related system of writing, such as that of Mesoamerica. also may refer to an individual symbol.

Histogram A graph of the number of measurements in interval form.

Horizon Usage includes a soil horizon or a cultural horizon (1) layer or assemblage associated with geological strata or archaeological contents, (2) the geographic extent of similar artifacts and design in space.

Hunter–gatherers People who obtain their food from wild plant and animals, not domesticated species. Also called foragers. Contrasts with farmers.

Hydrocarbon One of many organic compounds that contain only carbon and hydrogen.

Hydroxyapatite The mineral component of bone, $Ca_{10}(PO_4)_6(OH)_2$.

In situ (Latin) An object in its original position of discard or deposition, in place, primary context.

Inductively coupled plasma–mass spectrometry (ICP–MS) Archaeometry technique, samples introduced to plasma source are ionized and elemental mass and concentration are measured.

Inferential statistics Used for making decisions about data and relationships among variables; inferential statistics use probability and confidence limits for comparison and decisions. Chi-square, *t*-test, *f*-test are kinds of inferential statistics.

Ingot A casting of pure metal intended for transport and reuse, usually oblong or disk-shaped.

Inhumation Burial of all or part of the corpse, contrast with cremation.

Inorganic compounds Molecules that do not contain carbon.

Ion Electrically charged atoms that have lost or gained electrons.

Infrared (IR) spectroscopy Instrument that provides compositional information about specific compounds, by inducing vibrations within a molecule.

Isotopes Slightly different atoms of the same element with the same atomic number, but a different numbers of neutrons.

Kouros Ancient stone statue of a nude Greek youth.

Leguminous plants An erect or climbing nitrogen-fixing bean or pea plant.

Lipids A generic category of greasy compounds including fats, oils, waxes, sterols, and triglycerides, that are constituents of living tissues.

Lithic assemblage The complete set of stone artifacts found at an archaeological site.

Lithics A generic term used for stone artifacts in archaeology and more specifically for flaked stone artifacts.

Living floor The actual places where people lived and carried out their activities.

Macroscopic Visible to the naked eye.

Magnetometer (Aka gradiometer) measures the earth's magnetic field at an archaeological site to located buried walls and pits.

Mass spectrometer Any analytical instrument that records components of a spectrum by mass.

Material culture Tangible, surviving evidence of human activities.

Mean The average for ratio scale data calculated by dividing the sum by the number of numbers.

Median The exact middle number of the nominal or ordinal values.

Mesoamerica Geographic and anthropological term for the area of Mexico, Guatemala, Belize, and parts of Honduras and Salvador where several early civilizations including the Aztec and Maya emerged.

Metal detectors Instruments that emit an electromagnetic field that is disrupted by the presence of metal objects in the ground, used for finding buried metal objects.

Micromorphology The study of anthropogenic sediments at a microscopic level.

Microscopic Visible only with magnification.

Microwear analysis Microscopic studies of damage and polish on the edges of stone artifacts to reveal the materials that were worked.

Migration Movement of new people into an area.

Mitochondrial DNA (mtDNA) Modern genetic material taken from the mitochondria, inherited only through the maternal line.

Molecular archaeology Sometimes used to refer to the organic component of archaeological chemistry and particularly to the investigation of ancient DNA in plant and animal remains, including humans. Sometimes called biomolecular archaeology.

Molecule A combination of atoms held together by chemical bonds.

Myoglobin A protein found in human tissue, its presence in human feces is used as evidence for cannibalism.

Native American Graves Protection and Repatriation Act (NAGPRA) Federal legislation intended to protect and return certain archaeological human remains and culturally significant artifacts to native Americans.

Neutron Particle in the core of an atom with no electrical charge.

Neutron activation analysis (NAA) Archaeometry technique using a neutron bombardment to release detectable element-specific gamma rays in samples.

Non-arboreal pollen (NAP) Pollen from plants other than trees.

Normal curve The standard, or normal, shape of measured values plotted in a frequency diagram.

Nucleic acid Compounds found in all living cells and viruses, composed of purines, pyrimidines, carbohydrates, and phosphoric acid.

Observation Term used for each value recorded in a data set.

Obsidian A glassy rock produced in volcanic conditions, excellent material for stone tools.

Ochre A red, yellow, or brown iron mineral sometimes found in prehistoric graves.

Old World The term describes the world as known prior to the European discovery of the Americas (the New World) and included the continents of Europe, Asia, and Africa.

Ordinal scale of measurement Ranked information with an ordered relationship between numbers.

Organic compounds The molecules of living organisms with the element carbon as a base.

Paleobotany Study of fossil plants.

Paleoethnobotany The study of plant use by both living and prehistoric peoples.

Paleontology Study of fossil animals.

Palynology The study of pollen from plants for information on species, environment, and climate.

Parenchymous tissues Parenchyma is plant storage tissue, commonly found in roots, tubers, rhizomes and corms.

Parry fracture A distinctive break in the forearm resulting a blow to an arm raised in protection.

Paste Mix of clay and other materials used to make pottery.

PCR See "Polymerase Chain Reaction."

Periodic table Summary information for the known elements, organized by atomic weight and relationships among elements.

Petrographic microscope A specialized version of a binocular microscope designed for the study of thin sections of rock or pottery.

Phase A particular period in time and space where an assemblage occurs.

Plan view A bird's eye or top down view of a site or region. A kind of map of the features and characteristics of a place. A standard representation of archaeological sites and areas.

Plasma The gaseous state of hot ionized material consisting of ions and electrons used as a source for ions in spectrometry.

Political organization The use and distribution of status, power, and authority within a society.

Pollen Covering of the gametes of flowering plants released in sexual reproduction.

Polymerase chain reaction (PCR) Technique in genetic studies to increase quantities of DNA sample by rapid cloning.

Population (1) All of the people living at a place or in a region. An archaeological population generally refers to the people related through membership in the same group. (2) All of the items or units of interest in statistical sampling.

Pottery Ceramic container.

Precision The measure of how exactly an instrument can reproduce the same measurement.

Prehistory The time in the past before written history, often synonymous with archaeology.

Primary context An object in its original position of discard or deposition, in place (Latin: in situ).

Protein Complex organic macromolecule composed of more chains of amino acids containing carbon, hydrogen, oxygen, and nitrogen; fundamental components of all living cells and many substances such as enzymes, hormones, and antibodies.

Proton Particle in the core of an atom with a positive electrical charge.

Provenience The place of discovery or origin. Where an item was found or came from (aka provenance in classical archaeology).

Provenience postulate States that if differences within a source of material are less than differences with other sources, then it is possible to distinguish individual sources, or provenience.

Radiocarbon A radioactive isotope of carbon (^{14}C, carbon-14); an important dating technique in archaeology.

Radiopotassium, or potassium–argon, dating Dating technique for old samples that is based on half-life for decay of potassium into argon in new rock.

Raman infrared spectroscopy A particular wavelength from IR in the electromagnetic spectrum is projected onto a sample and the diagnostic wavelengths of the light scattered at a high angle are recorded.

Ratio scale of measurement Measurements with a true zero point made using an instrument.

Reciprocity The exchange of items of roughly equal value.

Redistribution The movement of goods to a central place from where they are rationed or portioned out to select members of society.

Relative dating Method of dating that determines whether an object or layer is older or younger than another.

Research design The overall strategy of intended methods, research area, and planned analysis for answering a question or questions about the past.

Residue Traces of physical and chemical remains on archaeological materials such as pottery, stone tools, and other artifacts.

Resistivity meter Used to measure electrical conductivity in soils that may be due to the presence of buried disturbances such as fireplaces, burials, or other structures.

Sample A sample means a portion of a whole as a noun and to take a part of a deposit, site, feature, or artifact for analysis as a verb. The term sampling is used to describe the process of taking a sample. This can be a one-time event, a series of actions, or a statistical process. Statistical sampling is a specific method for taking samples that allows probability estimates to be made about the population that is being sampled. Archaeologists almost always take samples, but only rarely is this done in a statistical fashion.

Sampling fraction The portion of the whole population or mass that is sampled.

Scale (1) Different levels of discovery, analysis, and interpretation in archaeology, or (2) the size of a map relative to the area it portrays.

Scale of measurement Measurements can be made using nominal, ordinal, or ratio scales of numbers.

Scanning electron microscope See "SEM."

Scatterplot A single graph combining two sets of numbers simultaneously.

Sediment Any particulate matter (clay, sand, silt, mud, gravel, leaves, shell, and other materials) that can be transported by water or other fluids, opposite = rock.

SEM Scanning electron microscope.

Sensitivity The measure of the smallest amount that can be reliably measured.

Settlement pattern The organization and distribution of human settlement across the landscape.

Sherd Broken piece of pottery.

Silica SiO_2, the major mineral component of sand.

Site Accumulation of artifacts and features, representing a place where people lived or carried out certain activities.

Social organization Structure of human society based on relationships among members and hierarchical arrangements.

Soil In situ weathered sediments on the earth's surface with specific physical and chemical characteristics.

Species Scientific classification of plants and animals uses a hierarchy of groups including class, family, and a number of others. Species is a very specific group of organisms that can mate and produce sexually viable offspring. Modern humans belong to the genus *Homo* and the species *sapiens*.

Specimen Any material collected for scientific analysis.

Speleothem Cave formation, a secondary mineral deposit in the form of stalagmites, stalactites, flowstone, and other features.

Standard deviation (s.d.) The square root of the variance, a single measure of spread.

Starch grains Microscopic grains of a complex carbohydrate found in certain species of plants.

Sterol Unsaturated solid alcohol, such as cholesterol and ergosterol, present in the fatty tissues of plants and animals.

Subsistence Food; refers to how humans obtain food, hunter–gatherers vs. farming.

Subtractive technique The continuous removal of material from a larger original piece in the manufacturing process; examples include stone working and wood carving.

Synchronic Dealing with a moment in time, a single time period.

Taphonomy The study of what happens to an organism after its death, including decomposition, post-mortem transport, burial, and the biological, physical, and chemical changes.

Technology The material, equipment, techniques, and knowledge that allows humans to convert natural resources into tools, food, clothing, shelter, and other products they need or want.

Temper A non-plastic substance intentionally added to clay in order to reduce breakage caused by shrinkage and firing.

Thermal ionization mass spectrometer (TIMS) A scientific instrument for measuring isotope ratios of heavier elements.

Thermoluminescence (TL) dating Technique for absolute dating based on the principle of the rate of accumulation of TL after heating, used with burned flint and clay.

Tool Any equipment, weapon, object intentionally modified by humans to change the environment around them.

Trabecular bone Spongy bone tissue found in the interior of bone.

Trade Economic transactions between individuals or groups involving bartering, buying, or selling.

Trophic level Position in the food chain, e.g., herbivore, carnivore, bottom-feeder.

Ultrasonic cleaner Lab equipment using ultrasound in liquid bath for cleaning.

Variance A single measure of spread or range in ratio data.

Wet lab A chemistry facility with lab tables, equipment, and running water.

X-ray diffraction (XRD) Method for measuring mineral components of inorganic solids using distinctive patterns of X-ray scattering.

X-ray fluorescence (XRF) Archaeometric method for measuring element abundances in inorganic materials; X-rays are used to excite atoms to fluoresce and emit a characteristic signal for each element.

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