

# CHEMISTRY'S ROLE IN THE DEVELOPMENT OF HUMAN CULTURE

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## Earliest Chemistry

### FIRE!

- Charred bones in South Africa, 1 mY BP (*Homo habilis*, *Australopithecus robustus*)
- Hearths from 250,000 BP (*Homo erectus/sapiens*)
- Burned seeds, wood, and flint in Israel, 790,000 BP (*Homo erectus/ergaster*)

## The Benefits of Fire

- Protection
- Warmth (expansion into cold climates)
- Light (social interactions expanded)
- Food stabilization (cooking)
- Tool enhancement (annealing)
- Pyrotechnology

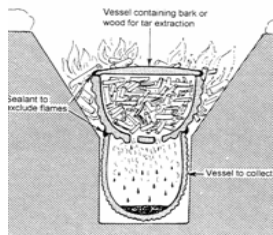
## The Next Chemical Step: Natural Products

### Unworked materials

- Bitumen, tar: stone tools, Syria, 36,000 BP
- Asphalt (bitumen + minerals): architectural materials, Zagros Mountains, Iran

### Worked materials (ca. 7000 BP Iran, Turkey)

- Pitch (heated wood, bark, coal...)
- Tar (distilled materials)

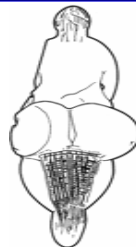


## Uses of Tar and Pitch

- Adhesives
- Sealants
- Coatings
- Medicines
- Incense
- Chewing gum
- Shampoo
- Wine ingredient

## Ceramics

- Clay can be shaped when wet (plastic).
- It hardens on drying and holds its form.
- Heating clay reworks the aluminosilicate framework
- (loss of structural water at 600°C) and reduces fragility.
- Ceramics include pottery, bricks, tiles, statues.



Musée de l'Homme, Paris

## Pottery

- Vitrification at 850°C
- Terra-cotta at 900°C (very porous, easily scratched)
- Earthenware at 900-1100°C (stronger, less porous, red from Fe)
- Creamware at 1100-1200°C (earthenware with Ca)
- Stoneware at 1200-1300°C (strong and not porous)
- Porcelain at >1300°C (special formulation)
- Fukui Cave, Japan, ca. 10,750 BC
- Çatal Hüyük, Turkey, 8500-8000 BC
- New World, 2500-2000 BC



Minoan



Attic Black-figured



Attic Red-figured



Chinese Porcelain

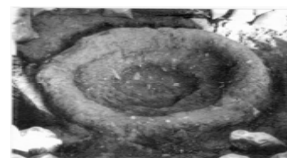
## Plaster and Lime

- Sinai, Levant, Mesopotamia before 6000 BC made synthetic stone.
- Limestone heated at 800-900°C forms lime by loss of CO<sub>2</sub>.
- Gypsum heated at 150-200°C forms plaster of Paris by loss of H<sub>2</sub>O.
- Addition of water forms a pasty material that may be applied to surfaces, which on drying hardens.

## Evolution of Metallurgy

- Native metals (Cu, Au, Fe)
- Cold working, forging
- Smelting (Çatal Hüyük, Turkey, ca. 7000 BC)
- Copper alloys (As, Sn, Zn, Pb) (up to five independent discoveries of bronze)
- Iron and steel

## Early Hearths



Chalcolithic Period (4th millennium BC), Los Milares, Spain  
P. T. Craddock

## Greek Furnace

- Slag tapping (R. F. Tylecote)
- Sixth century BC iron bloom furnace
- Shaft to improve draft



## Bronze



Chinese bronze (Antiki Trading Co.)



Igbo-Ukwa bronze (Africa)

## Early Glass

- Silica (the *former*) melts at 1710°C.
- Alkali cations (the *modifier or flux*) such as Na<sup>+</sup> or K<sup>+</sup> lower the melting point to under 1000°C.
- Less soluble cations (*stabilizers*) prevent dissolution.
- Hence SODA-LIME glass, but probably produced from two batches of raw materials.
- True glass in Egypt or Mesopotamia
- ca. 2000 BC.
- Colored glass: Egypt. enameling (glass and metal).
- Decolorants: Sb and Mn (Roman glass).
- Cased glass (layers of glass, as in cameo glass).
- Other modifiers: Pb (Islamic) or Ba (China).



Egyptian glass



Egyptian enamel

## Classical Glass

Roman, Portland Vase, 1<sup>st</sup> century AD, layered (cameo)



## Conclusions

The controlled use of fire provided protection, warmth, and, later, a means to preserve food. Eventually fire was used to rework bitumen into tar or pitch, of clay into ceramics, of limestone or gypsum into plaster, of sand into glass, and of minerals into metals and alloys. Chemistry was present at nearly every stage of the development of early human culture.