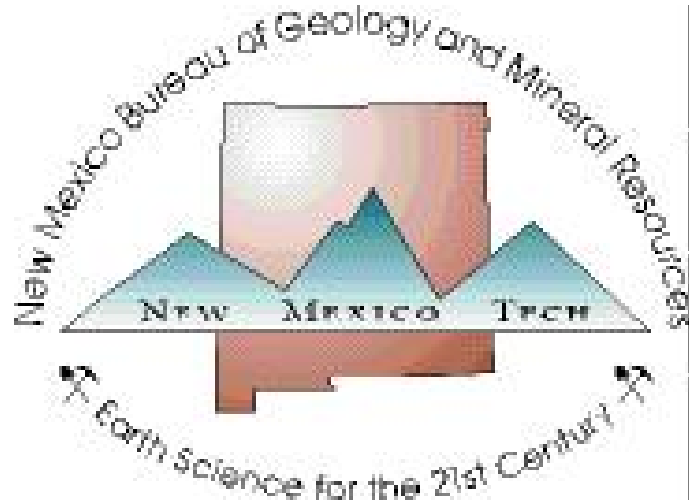


# St. Cloud Winston Zeolite Mine, Winston, NM—2020



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**New Mexico Tech**

# Zeolites are

- A group of minerals known as aluminosilicates (composed of aluminum, silica, and other ions)
  - Approximately 48 natural zeolites and 120 synthetic zeolites exist
- Framework structure encloses cavities (or pores) occupied by cations and water molecules, both of which have considerable freedom of movement, permitting ion exchange and reversible dehydration
- Composed of a three-dimensional crystal lattice with loosely bound cations
- Able to hydrate and dehydrate without altering their crystal structure
- Have fixed pore sizes and active sites in the crystal lattice

New Mexico is the leading state in the US in zeolite production



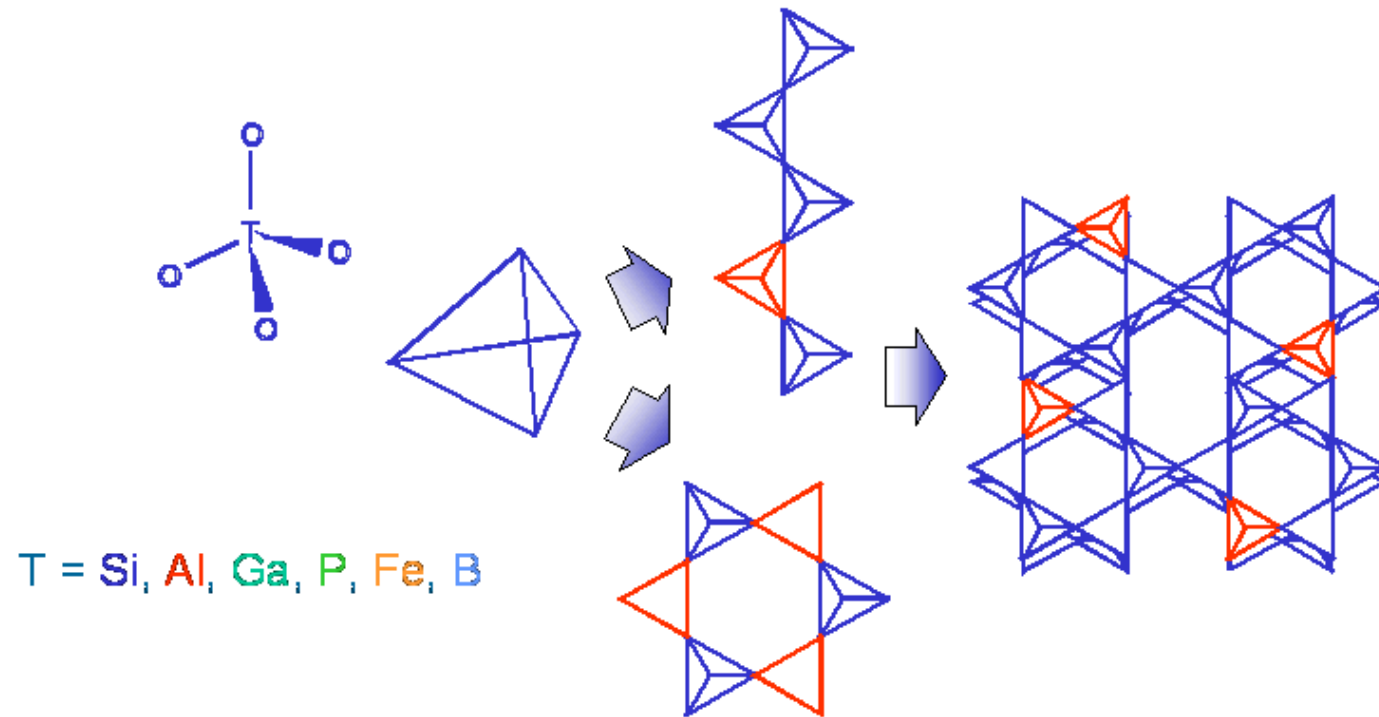
# Zeolite Physical Properties

- Soft to moderately hard,  $H=4-5$
- Low density
- Transparent to translucent
- 48 natural Zeolites
- Over 120 synthetic Zeolites
- Industrially speaking, the term zeolite includes natural silicate zeolites, synthetic materials, and phosphate minerals that have a zeolite like structure



# Zeolite structure

The primary building unit of zeolites are cations coordinated tetrahedrally by oxygen. These tetrahedra are connected via corners, thus forming the crystal structure of the specific zeolite.

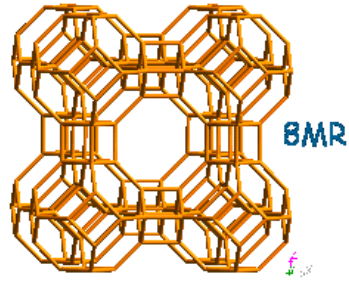


Source of diagram: [www.mpi-muelheim.mpg.de/.../zeolites\\_c2.html](http://www.mpi-muelheim.mpg.de/.../zeolites_c2.html)

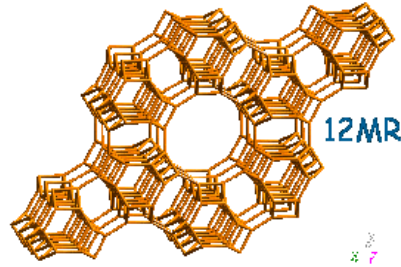
# Properties of Zeolites

All commercially useful zeolites owe their value to one or more of three properties: adsorption, ion exchange, and catalysis

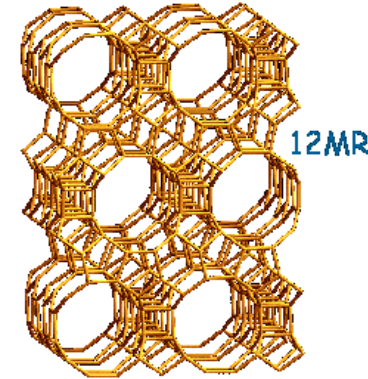
LTA (4.1 Å)



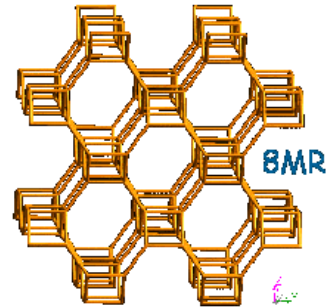
LTL (7.7 Å)



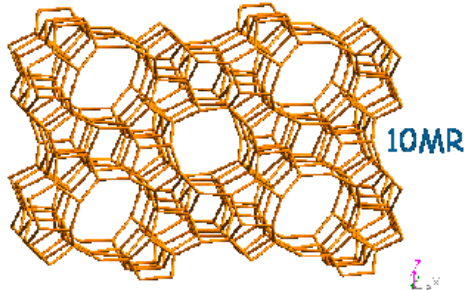
BEA (6.6 × 6.7 Å)



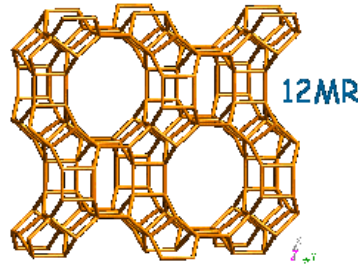
GIS (4.5 × 3.1)



MFI (5.5 × 5.1 Å)



MOR (7.0 × 6.5 Å)



# Zeolites uses

- Animal feed (improves animal health, manages nitrogen and ammonia emissions, lowers mortality)
- Water treatment (treating drinking, municipal, agricultural, and industrial waste waters)
- Soil amendment (increases soil's nutrient holding capacity and water retention, prevents toxicity)
- Odor and moisture control (industrial, farm, and household uses)
- Environmental remediation (ion exchange for removal of radioactive and heavy metal cations)
- Specialty applications (food preservation, grease and oil absorption, and cement and pozzolan)
- Molecular sieves

# Geology

- Occur in rocks of diverse lithology, age, and depositional environments
- Closed-basins, saline, alkaline-lake deposits
- Nonmarine and shallow marine basins in volcanic terrains
- In New Mexico, Clinoptilolite, the main commercial natural zeolite, is found in geologically young volcanic ash altered by alkaline groundwater

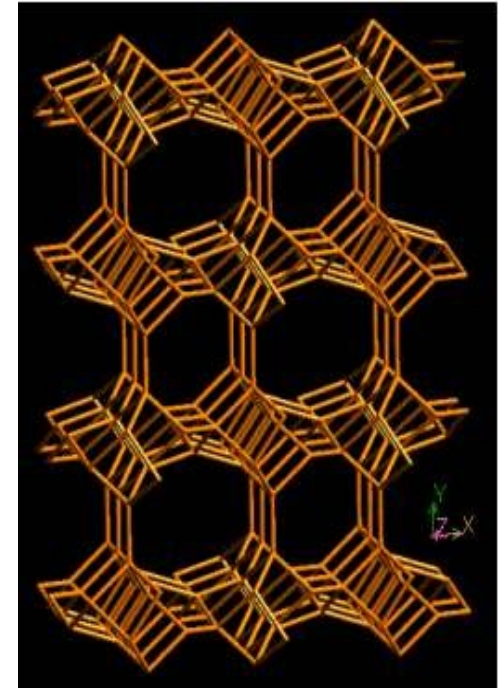
# Formation of Zeolites

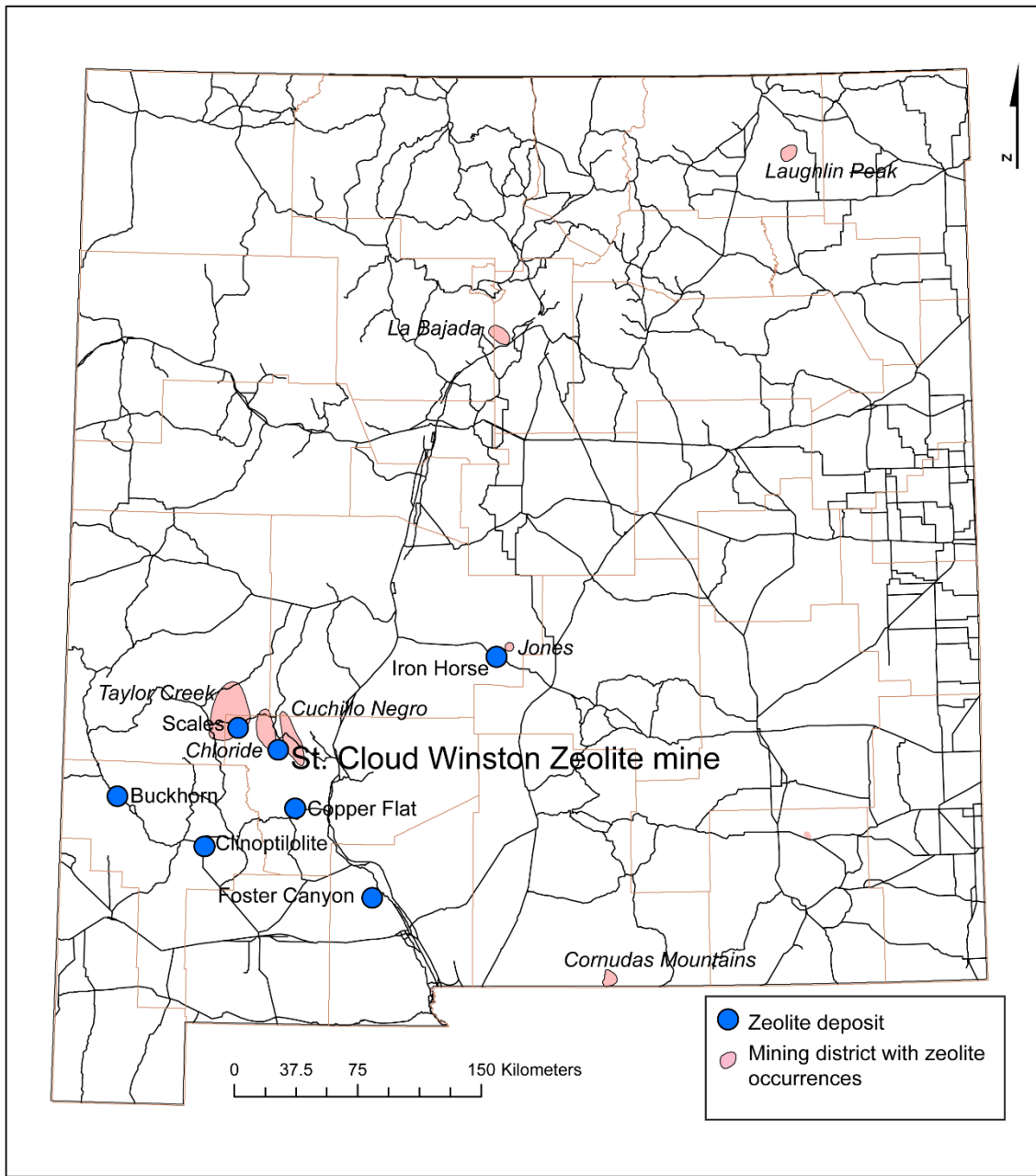
- Formed by alteration reactions
- Temperatures range from 27°C - 55°C
- pH is typically between 9 and 10
- Nature requires 50 - 50,000 years to complete the reaction
- Mostly altered volcanic glasses
- Fine-grained volcanic ashes or pumice particles are especially susceptible to alteration
- Starting materials can also be minerals, like nepheline, leucite, and feldspars
- Alteration in different environments: hydrothermal, saline or alkaline lakes, and groundwater
- The alteration conditions of these three environments are completely different with respect to chemistry, concentration, and pH of the reacting solution, solid/liquid ratio, temperature, reaction in closed or open system.



# Clinoptilolite Studies at NMT

- NMT Hydrology study under Rob Bowman (since has passed away) focused on the natural zeolite clinoptilolite
- Formula  $(\text{Ca}, \text{Na}_2, \text{K}_2)(\text{Al}_6 \text{ SiO}) \cdot 24\text{H}_2\text{O}$ .
- Clinoptilolite from the St. Cloud Mining Company
- Mine located near Winston, New Mexico
- St. Cloud is the largest producer of natural zeolite in North America
- Mineralogy of St. Cloud material:
  - 74% clinoptilolite
  - 10% feldspar
  - 10% quartz + cristobalite
  - 5% smectite





# Zeolite deposits in New Mexico

# St. Cloud Winston Zeolite Mine

- Started in 1991 (also known as Stone House Zeolite mine)
- Sells Winston zeolite
- 50,000 tons per year
- 2016 constructed a new processing facility
- 2018 conducted exploration program to delineate additional reserves

# Winston zeolite properties

- High surface area, high surface charge density (readily available cation exchange sites), and physical durability
- High calcium and low sodium content make it preferable in agricultural applications
- Low clay content makes it desirable in water treatment applications

Winston zeolite open pit (now reclaimed). The white unit is the zeolite and it is overlain by unaltered tuff.







Lighter color is the altered volcanic ash with clinoptilolite at the St. Cloud zeolite mine

# Mining St. Cloud Zeolite



St. Cloud's zeolite operation includes facilities for custom sizing, bagging, blending and manufacturing of added value products. St. Cloud sells zeolite primarily through a network of brokers, distributors and manufacturers.

# Zeolite is crushed and sized





# Various products



# Zeolite is bagged for shipping to customer



# St. Cloud Zeolite Plant



# Value of Zeolites

- Usually determined by cost of processing and added value
- Mining costs \$3-6/ton
- Processed \$30-120/ton
- Pet litter, fish tank, deodorant \$.50-4.50 kg
- Special apps = \$1000s /ton (radioactive waste filter media or catalysts in petroleum refining, etc)

# Transporting Zeolites

- Generally transported by highway or rail carriers in bulk, in one-ton super-sacks or in multi-wall paper bags, usually palletized
- Do not require special handling
- Costs affected by distance must transport to market
- Currently economical to ship from western US to eastern US for agricultural uses
- May change in future when imports from Cuba and Antigua become cheaper for eastern US to use
- Specialty zeolites worth shipping farther

# Future of Zeolites

- A healthy, growing industry with continued expansion into new applications and steady demand in industrial markets.
- Most of the activity and growth has been in the synthetic zeolite field.
- Natural zeolite market likely to continue on a slow and steady basis.
- Natural zeolites domestic market for catalysis and petroleum refining, nuclear waste treatment, odor control, pollution control, and energy cost and efficiency issues will continue and expand.
- Higher energy costs and greater environmental demands will spur zeolite production and sales significantly.
- For the next decade, natural zeolites should emerge as a better-defined mineral commodity, and North America will become a leading producer.

Web site: <https://www.stcloudmining.com/>