ME551/GEO551 Introduction to Geology of Industrial Minerals Spring 2012

BASIC CONCEPTS: MINING METHODS, TRANSPORTATION, MARKETING

Ore bodies come in many sizes and geometric shapes and mining methods must conform to each specific ore body and metal recovery economics.

Mining methods?

Mining methods

- Underground
- Surface
- Placer
- Leaching/solution

Surface

- Strip
- open pit
- quarry

http://www.uky.edu/KGS/coal/surface_equip.htm

Limestone Mine in Jasper County - Active Mine

Limestone Mine in Jasper County - Reclaimed to Water Impoundment

Fireclay Mine in Osage County - Prereclamation

Fireclay Mine in Osage County - Postreclamation

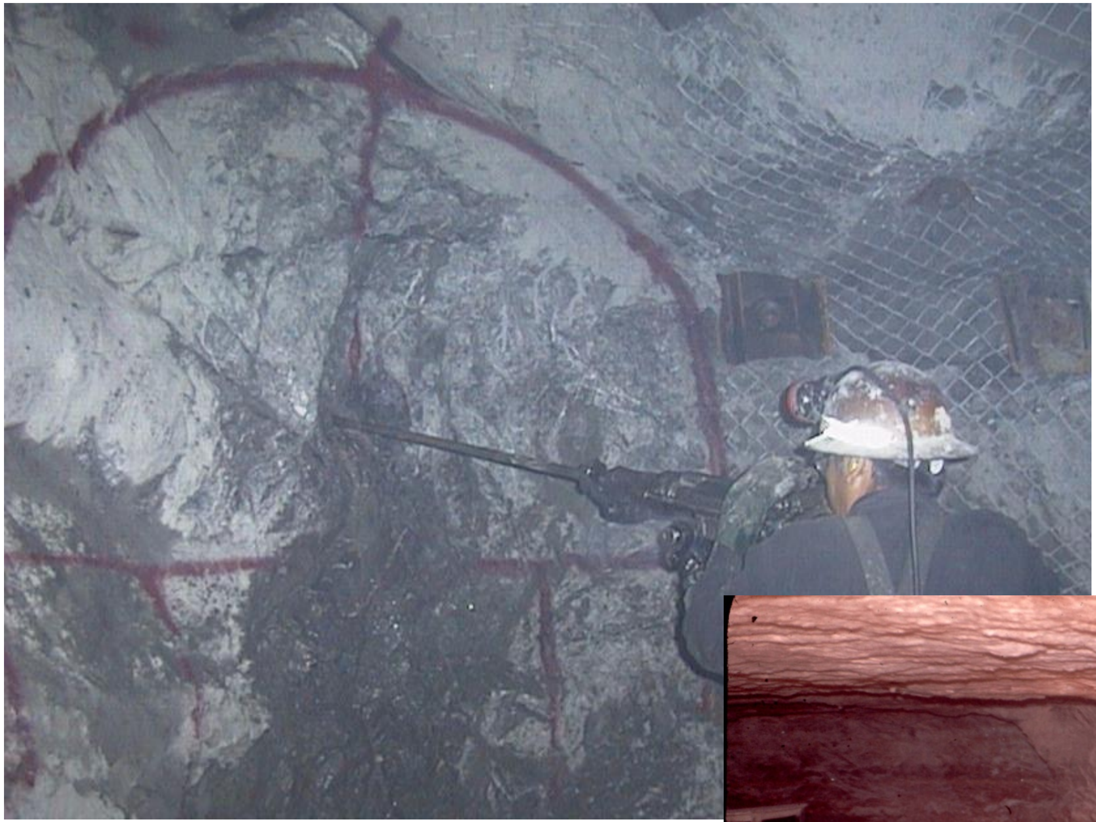
http://www.dnr.mo.gov/env/lrp/homeim.htm

Underground

- methods producing natural or minimal support (room and pillar)
- caving methods where failure of the back (roof or overburden) is required (sublevel caving, block caving)
- methods that require substantial artificial support (cut and fill or stope backfill)

Underground Mining Methods		
OPEN STOPE	ROOM AND PILLAR	SUBLEVEL
CUT AND FILL	SHRINKAGE	SQUARE SET
TOP SLICING	SUBLEVEL CAVING	BLOCK CAVING
SOLUTION	UNDER-CUT AND FILL	VERTICAL CRATER RETREAT
STULL STOPES	SLUSHER STOPES	GLORY HOLE

http://www.digistar.mb.ca/minsci/ug/undergm.htm

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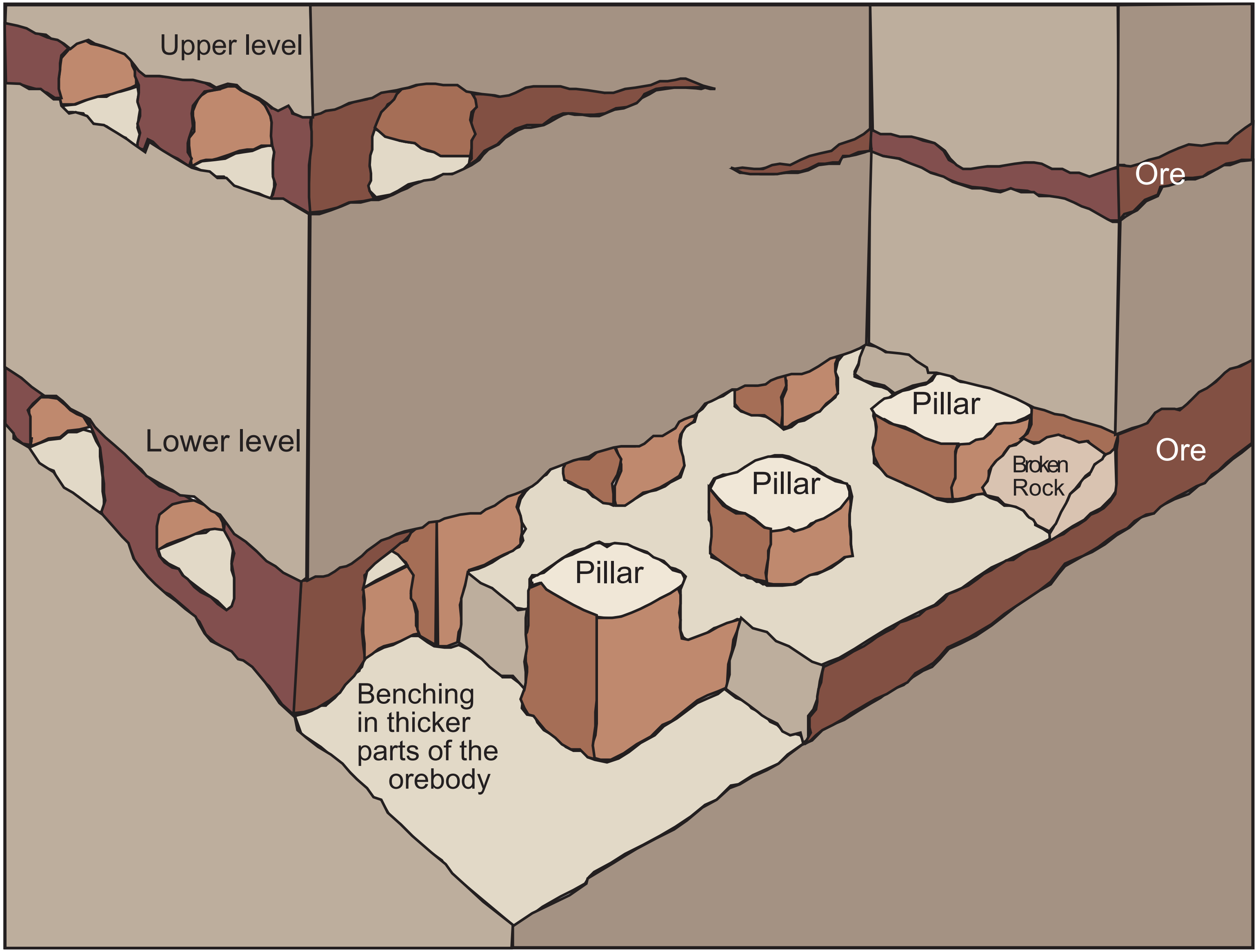
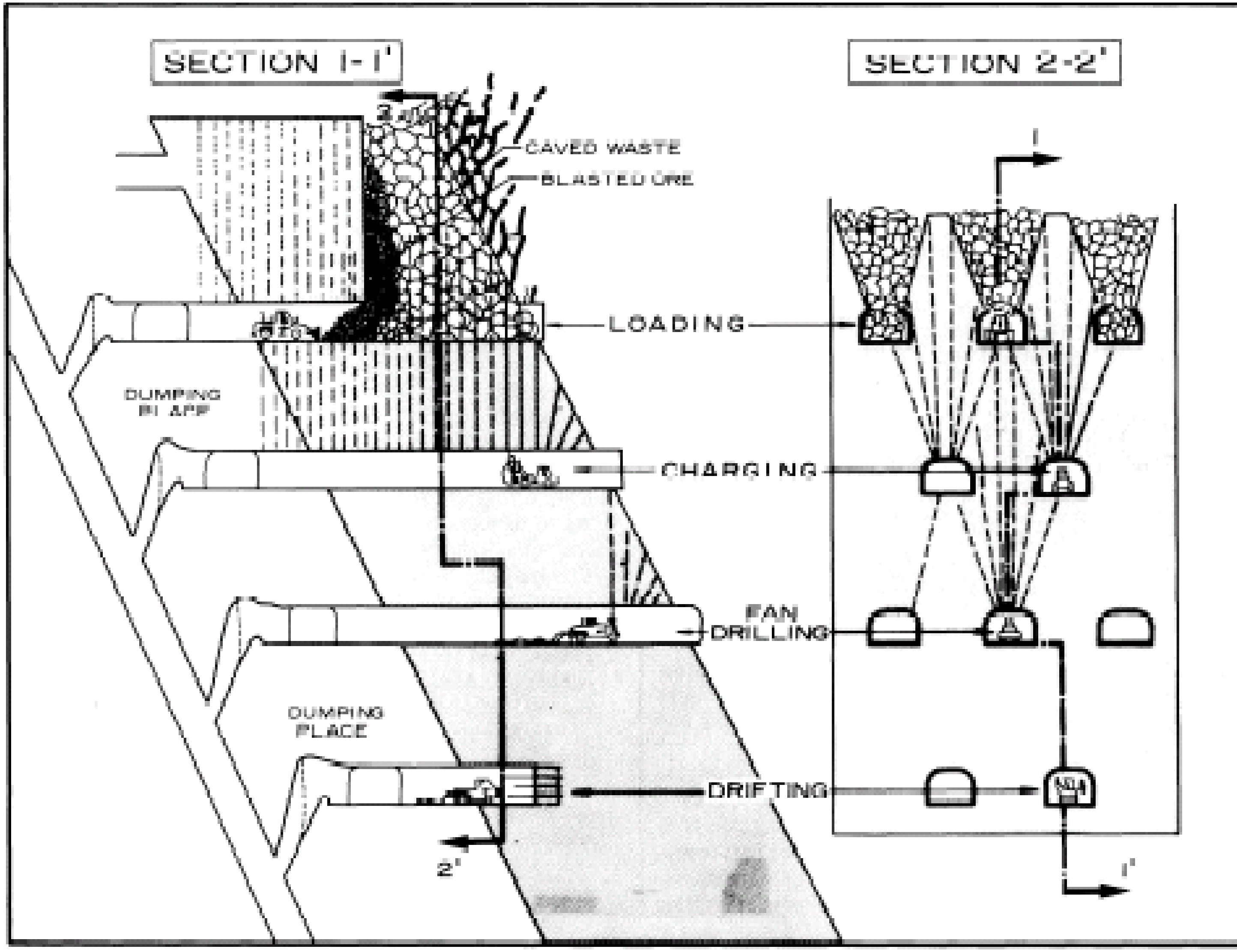
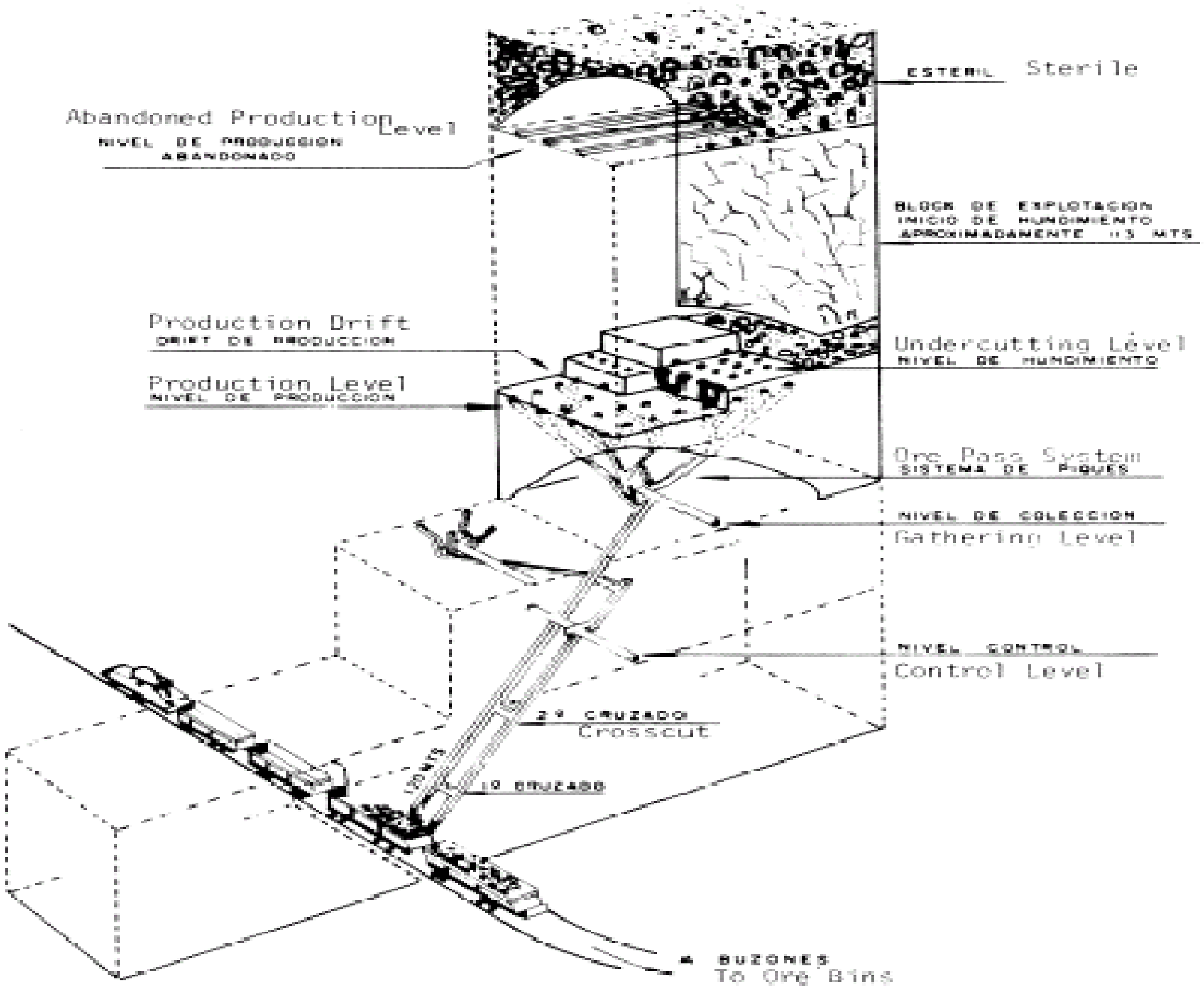


Room and pillar



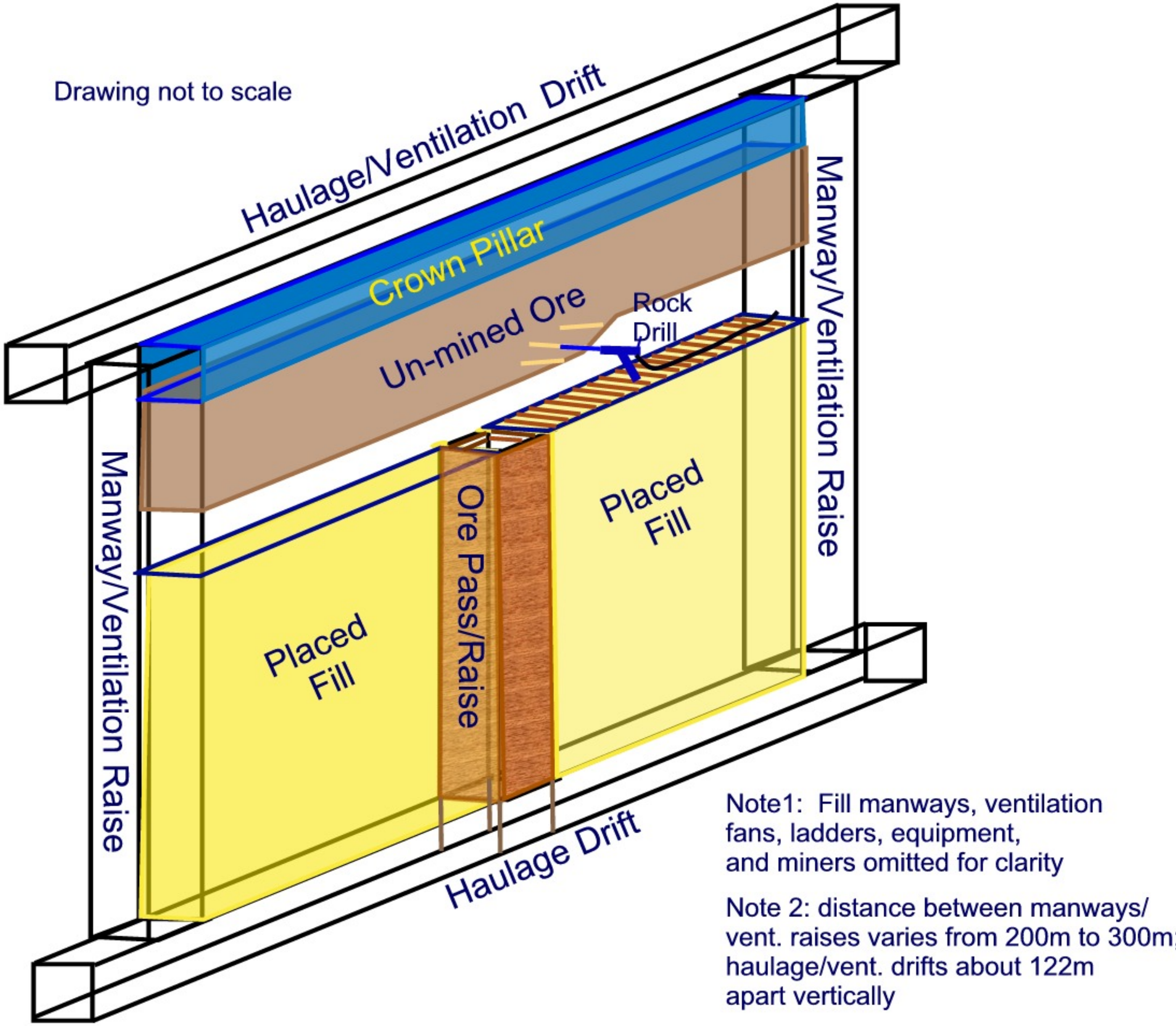
Sublevel caving

Kvapil, 1992, with permission from SME



Block caving at El Teniente

from Julin, 1992, with permission from SME

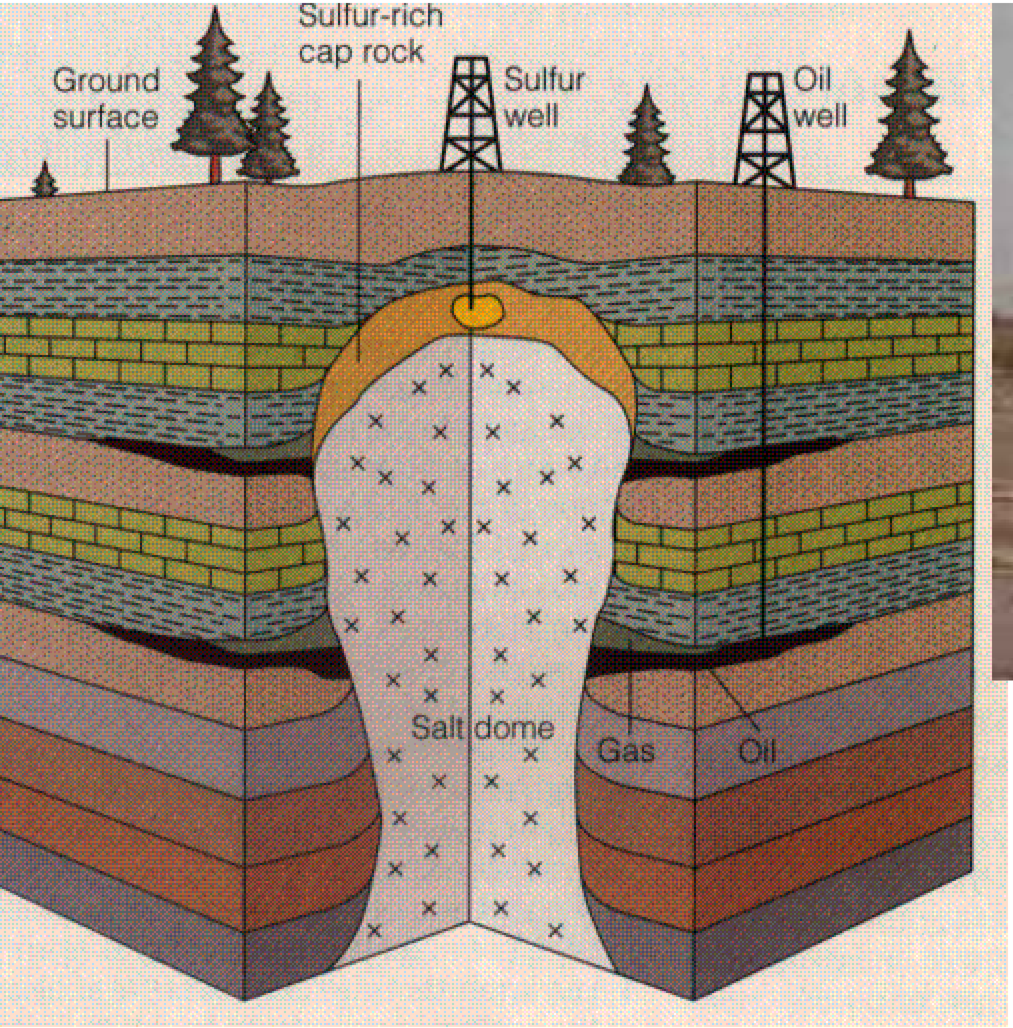


Cut-and-fill method

Placer mining

http://www.homestead.com/theclaimpost/PlacerMiningMethods.html

Solution mining



http://www.saltinstitute.org/images/saltdome.gif

http://web.ead.anl.gov/saltcaverns/desc/index.htm

http://www.uic.com.au/nip40.htm

Future methods

- Ocean mining
- Deep sea nodules
- Asteroid mining
- Robots

1.2.6.2 Evaluation of Mining Methods and Systems [Sec. 23]

Earlier discussions dwelt on individual mining methods, or classes of methods, their characteristics and conditions. Finally, an overall comparison and evaluation and some selection procedures are needed, limited here to traditional methods.

Method Features: It is not possible to compare all the features associated with surface and underground methods, but one can note the principal advantages and disadvantages of the two locales.

1. **Mining cost:** Except in rare cases, relative costs (quarrying is an exception) are significantly less for surface mining; underground costs are higher but variable, with caving lowest and supported highest.
2. **Production rate:** All surface methods (except aqueous and quarrying) moderate to high; underground low to moderate (except high for caving and some unsupported).
3. **Productivity:** Surface much higher than underground in nearly all cases.
4. **Capital investment:** Generally small for aqueous and large for other surface, but larger for underground; surface equipment more expensive, but underground development costlier.
5. **Development rate:** More rapid for surface.
6. **Depth capacity:** Limited for surface (except for solution mining); range from limited (unsupported) to somewhat unlimited (supported) underground.
7. **Selectivity:** Generally low for surface, variable underground.
8. **Recovery:** Generally high for surface (except aqueous), variable from low to high underground.
9. **Dilution:** Generally less for underground (except for caving).
10. **Flexibility:** Underground tends to offer more flexibility than surface, although surface may be more adaptable to change.
11. **Stability of openings:** Generally higher for surface; more difficulty to attain and maintain underground.
12. **Environmental risk:** Substantially higher for surface, except that subsidence may be severe with underground methods.
13. **Waste disposal:** May be serious problem for surface, minor underground.
14. **Health and safety** (including atmospheric control): Vastly superior for surface.

http://books.smenet.org/Min_Eng_Hndbk/meh2-toc.cfm

Industrial Mineral, use	Applicable Processing Done in Arizona
Calcium carbonate from **limestone** and **marble** for mineral filler as well as for raw material for lime and cement plants	1. Filler uses; fine dry grinding 2. Lime; grinding and calcining 3. Cement; grinding and blending with silica, alumina, and iron sources, kilning to produce clinker, regrinding with added gypsum; may be blended with admixture chemicals at concrete producers
Bentonite for desiccants and for bleaching and clarifying of edible oils	Processed out-of-state for use as desiccants, and as acid activated clay for use in clarifying edible oils and removal of organic contaminates from leach solutions
Sand and gravel for construction aggregate	Processed by crushing, screening, and washing; some flocculation chemicals may be used in reclaiming wash water
Diatomite for metallurgical process insulation	Processed by crushing, gas fired drying, and sizing by cyclones and bag houses
Tile and brick **clay**	Blended with other clays, grog, and slate, extruded and fired into structural clay products such as bricks, sewer pipe, and roof tile
Salt	Recovered as brine from solution mining and harvested from solar evaporation ponds; synthetic zeolites are added to some final products for use in water softeners
Cinders	Screened for use as specialty aggregate
Pumice for laundry uses and light-weight aggregate	Screened and used directly or with adsorbed oxidants and bleaches for fabric treatment as in stone-washed denim; screened for use as light-weight aggregate
Zeolites	Selectively mined, crushed, heat activated at 400 degrees F rolled, and screened to produce sized products; also processed out-of-state; used for RAD control, adsorbents, and molecular sieves
Stone	Quarried and shaped
Perlite for filters	Selectively mined, crushed, and dried; shipped out-of-state for popping and manufacture into filters
Gypsum for wall board and agriculture	1. For wall board, selectively mined, crushed, roasted to produce plaster-of-Paris, rehydrated and fabricated into wall board 2. For agriculture, selectively mined and crushed 3. For cement additive - selectively mined, crushed, washed, dried, and screened
Silica flux	Selectively mined and crushed
Micaceous **hematite** for pigment	Selectively mined (reclaimed) from dumps and tailings, screened and fine sized

http://www.admmr.state.az.us/Publications/circ065improcess.html

ASSIGNMENT

Read by March 5

- Barker, J. M., and McLemore, V. T., 2005, Sustainable development and Industrial minerals: Mining Engineering, December, p. 48-52.
- McLemore, V. T., and Dennis Turner, D., 2006, Sustainable development and exploration: Mining Engineering, February, p. 56-61.