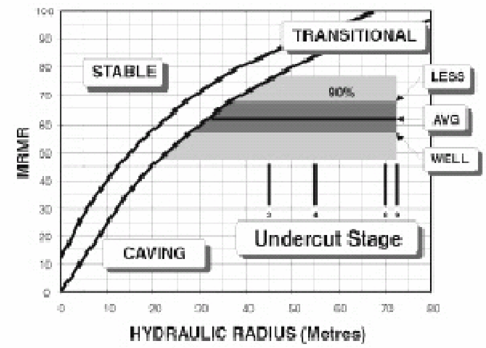
Notes on Block Caving†

Required Ore Characteristics

- large massive orebodies (veins should have steep dip) of regular shape with sides dipping steeply
- should have proper fracture pattern
    - For good fracturing, there must be at least 2 vertical joints, perpendicular to each other, and one horizontal joint. At least 50% of the ore should break in sizes less than 1.5 m, as most finger raises are of that diameter.
    - An idea on potential rock fragmentation is also obtained by various methods such as RQD or MRMR or Laubscher Caving Stability Graph. MRMR or mining RMR is similar to RMR but includes mining induced and blasting induced stresses in its rating. The Laubscher graph plots the MRMR against the hydraulic radius to identify stable and caving regions. Hydraulic radius is ratio of the surface area of the unsupported area and its perimeter.
        - To relate to active mines, Palabora mine (copper) in South Africa has MRMR between 57-70, which is on the higher side for block caving (typically block caving is not advised for MRMR over 50). The Henderson molybdenum mine outside of Denver, CO, has an average RQD of 49, while RMR ranges from 27 to 60 respectively.
    - Note that regional stress fields also have a say in the fragmentation pattern as well as the stability of the blocks.



- should be able to withstand undercutting
- no restrictions on grade, though usually used on low grades

Required Cap Characteristics: Cap is the waste rock above the ore

- the cap should be caveable
    - to prevent sudden massive failure
    - to transfer overburden weight to ore so ore is crushed. If the overburden weight is not transferred to ore, then ore pieces are large
    - to prevent weighting on excavations near production area
- the cap should not break into fine pieces as that dilutes the ore. Ideally, it should break into small pieces and be resistant to attrition
- the surface/overburden should be amenable to subsidence (low/no rainfall preferred, no inhabitation, not under a river, not under a large water table)

Development

- extensive. requires
    - undercutting
        - first, several parallel drifts driven at undercut level
        - long holes drilled and blasted from these drifts. Drawn from draw points
    - in some cases, cones, grizzly level, and finger raises
    - production level and/or haulage level
    - for trackless mining, some of the development is reduced (see Fig. 2.14 in the textbook)
- block sizes depend on ore characteristics
    - when ore is weak or highly fractured, small blocks are preferred as a large block may not be able to take the undercutting
    - when ore is of medium strength, panel caving is best
    - for strong ore, mass caving is used as a large undercut is necessary to get caving started

† Pages 67-70, Chapters 41and 42

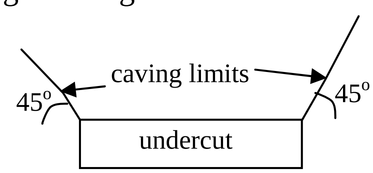
- the height of the block should be as high as possible as i) development per unit height gets reduced and ii) ratio of capping to ore reduced
    - the height also depends on ore geometry and strength
- the following should be considered in deciding the draw point spacing:
    - ore breakage sizes. The area affected by a draw point or its zone of disturbance is small when ore pieces are small. Therefore, draw points should be close when small ore pieces are anticipated. The opposite is true for large pieces
    - the zone of disturbance for adjacent draw points should overlap so that no ore is left behind
    - to ensure quick loading of trains, the spacing should be adjusted so that multiple cars can be loaded at the same time

Production

- a balance should be maintained between draw and caving
    - this is to ensure that uniform contact is maintained between broken ore and ore/cap above
    - it also reduces dilution
- if a stable arch forms, making caving difficult, widen to re-start caving
    - in rectangular openings, widening the length may not help if the arch formed over the breadth
- draw rapidly following an undercut to ensure no pillar is left as support
- control draw to control dilution

Caving

- *initial* caving area about the same as undercut area in weak rock. For strong rocks, it is smaller than the undercut area
- eventually, the caving area extends beyond the undercut area, following a 45 degree line from the undercut area
- most secondary blasting is done during the first 30% of caving
- sometimes the boundary is weakened to limit spreading of caving



Equipment

- designed for high production
    - multi-boom drill jumbos
    - high tonnage mucking
        - large scapers with low scraping distance, or
        - LHD's
- good haulage system
    - long trains with big cars can be used for haulage
    - in-pit crushing and conveying if long hauls

Advantages

- cheap, as little drilling and blasting
    - drilling and blasting may be higher if the fragmentation is bad. In Palabora, 70% of the ore may require secondary breakage in the first year. Depending on layout, mines can also use rock-breaker type equipment for breaking large fragments rather than blasting. In Palabora, a special remote controlled high reach (21m) drill rig is used to d&b high hang-ups.
- centralized production leads to easy supervision and safe working area
- easy ventilation
    - If diesel LHD's are used, ventilation requirements get stringent
- high production rates
    - Henderson mines cites 317 tons/hr from their LHD's
- good for low grades

Disadvantages

- narrow range of applicability
- high initial (development) cost
- difficult to maintain drifts in production area
- sudden increase in demand difficult to accommodate
- stoppage of drawing may close ore block due to weighting. Stoppage typically happens when product prices go down (example: Henderson mine and price of molybdenum)
- ore recovery could be low in adverse situations.
- bad draw practices may lead to high dilution.
- difficult to switch method of mining once started