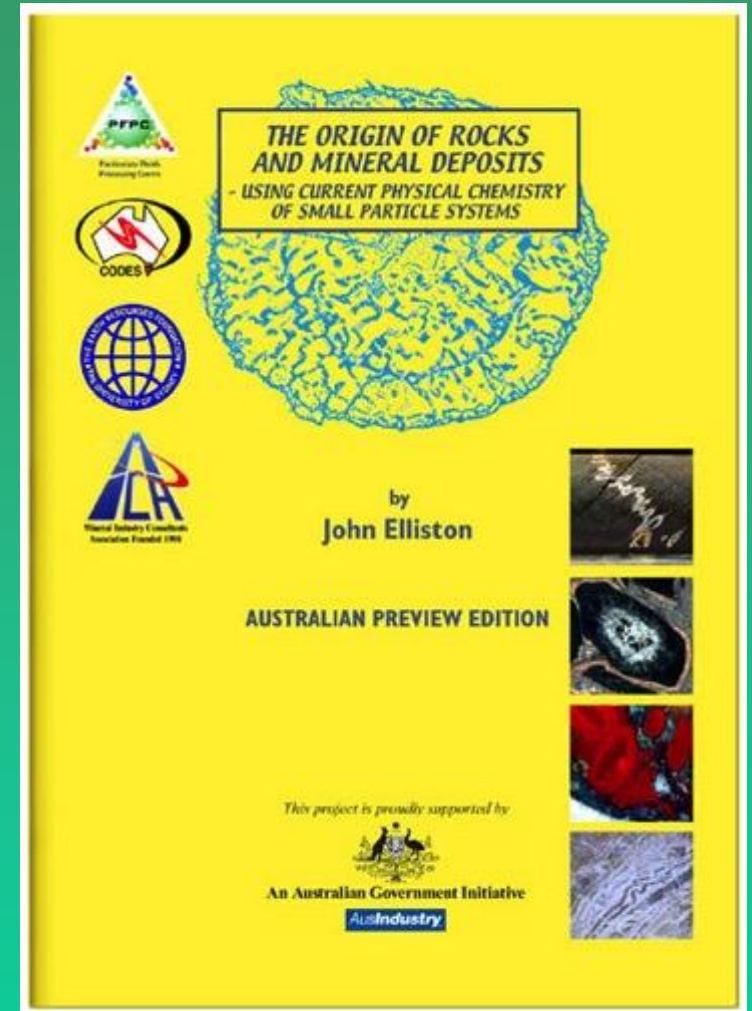




RETRACING THE SYSTEMATIC STEPS IN A VOYAGE OF SCIENTIFIC DISCOVERY

John Elliston



THE ORIGIN OF ROCKS AND MINERAL DEPOSITS

- using current physical chemistry
of small particle systems

John Elliston

INTERNATIONAL EDITION

OCTOBER 2016

It pays to try and
understand the
origin of mineral
deposits!

(International edition
soon to be released)



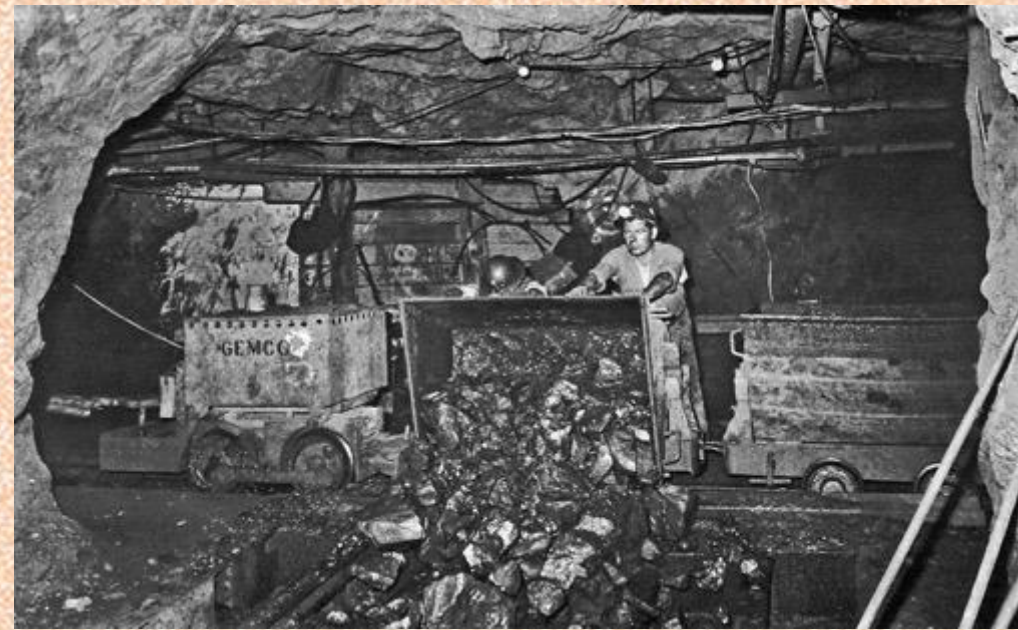
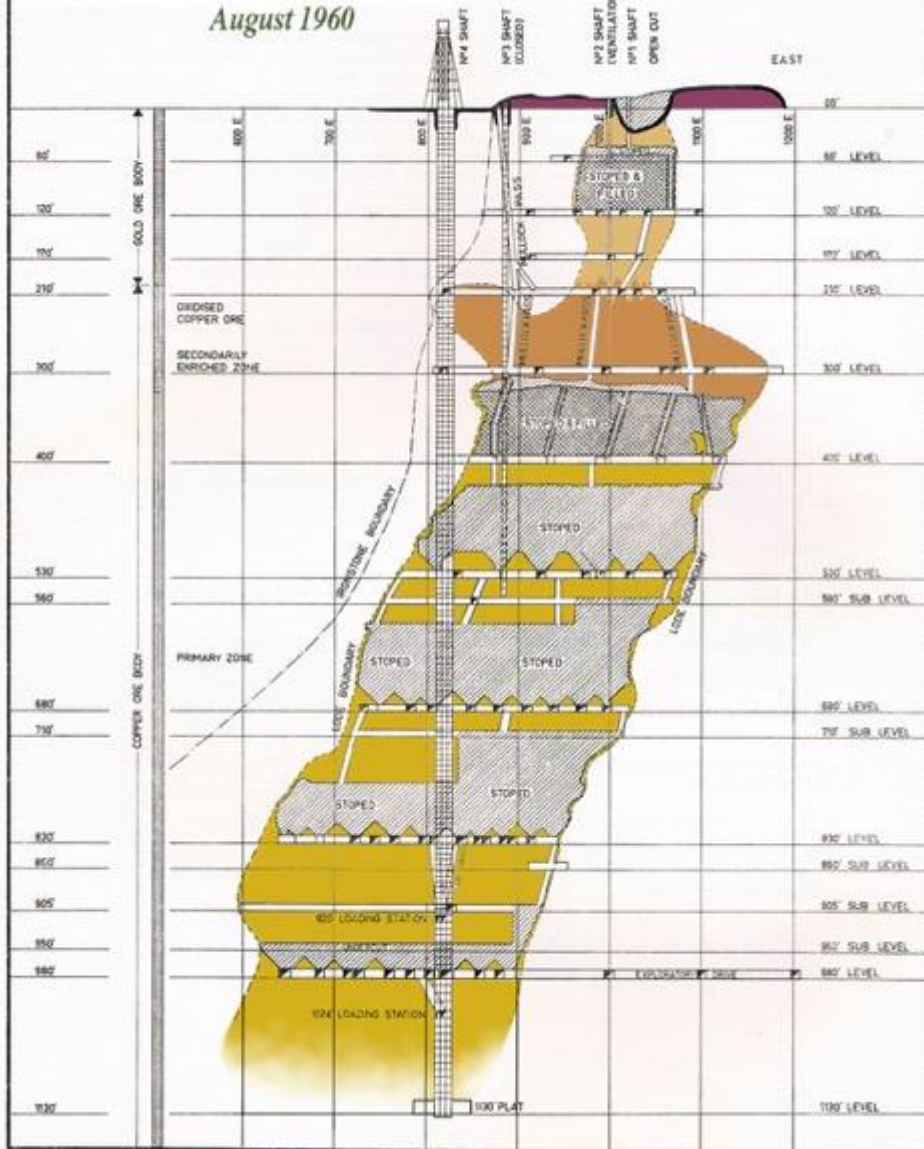
It all started with a small mining operation in Central Australia!

The Peko prospect struggled into production in 1949 and became the small Peko Mine at Tennant Creek.

It is shown here in 1957.

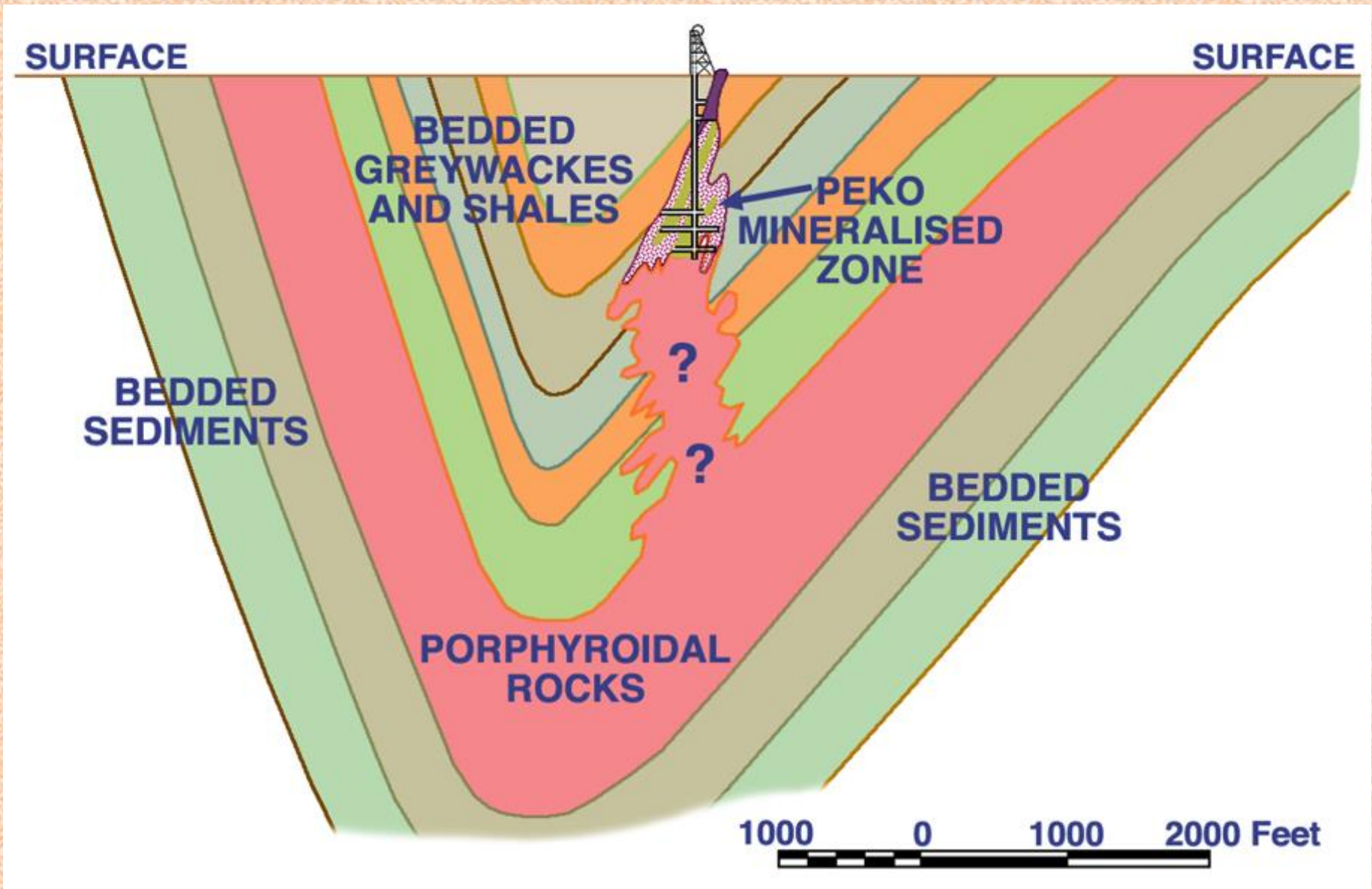


*Longitudinal Section of Peko Mine Workings
August 1960*



Peko had rich ore (7-8% copper and 4.3 g/t gold). It produced rich concentrates – but there was not much of it!

Disaster was lurking **round the corner - by the end of 1960** Peko Mine was becoming desperately short of payable ore!

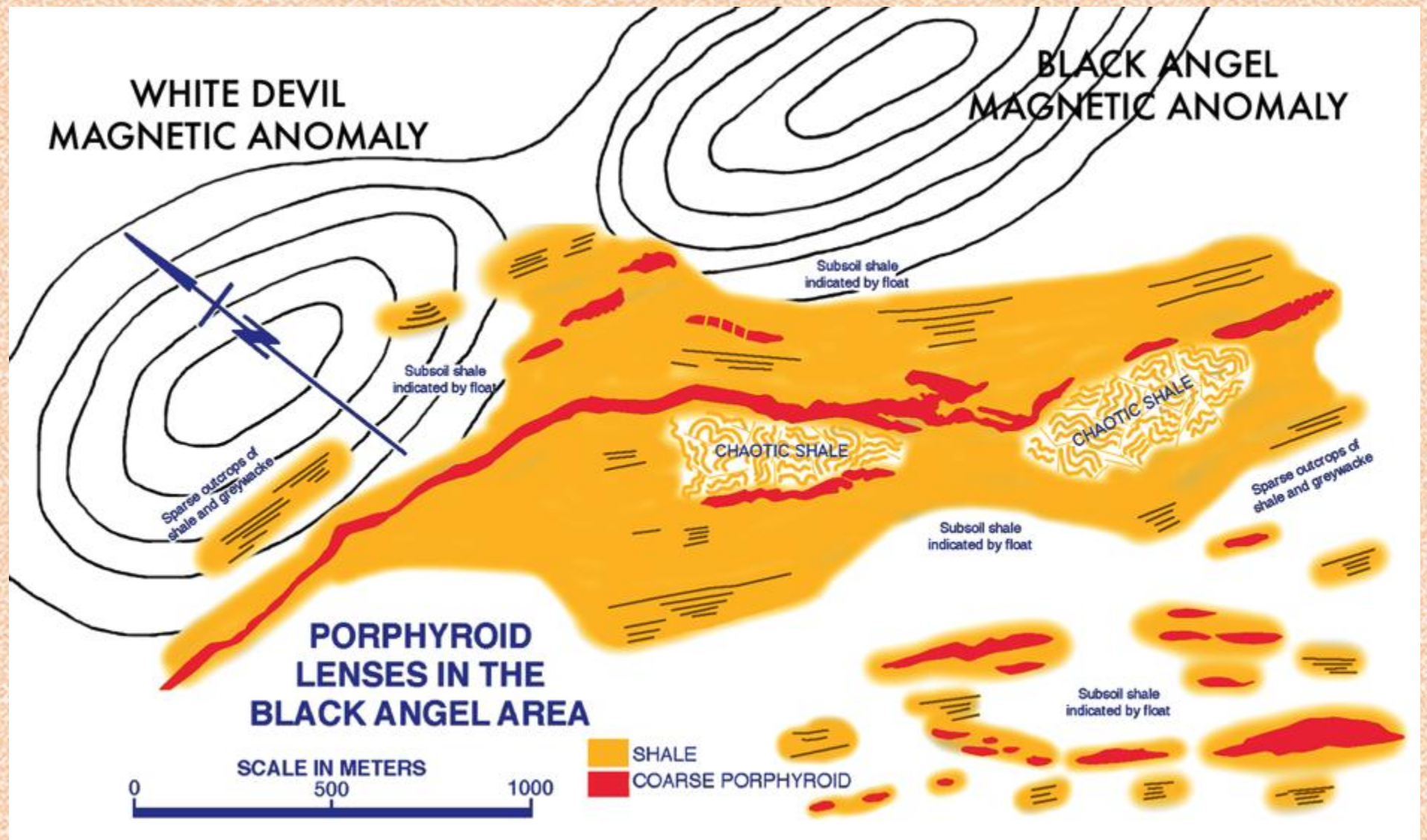


In 1957 it was thought that the Tennant Creek porphyroidal rocks were possibly the source of the ore deposits.





You'll find ore for us WON'T YOU? What a place to look for ore!
6500 square kilometres of desert in 1958.



The first approach was systematic geological mapping and testing magnetic anomalies. This prospect at Black Angel was one of the first to be mapped and drilled.



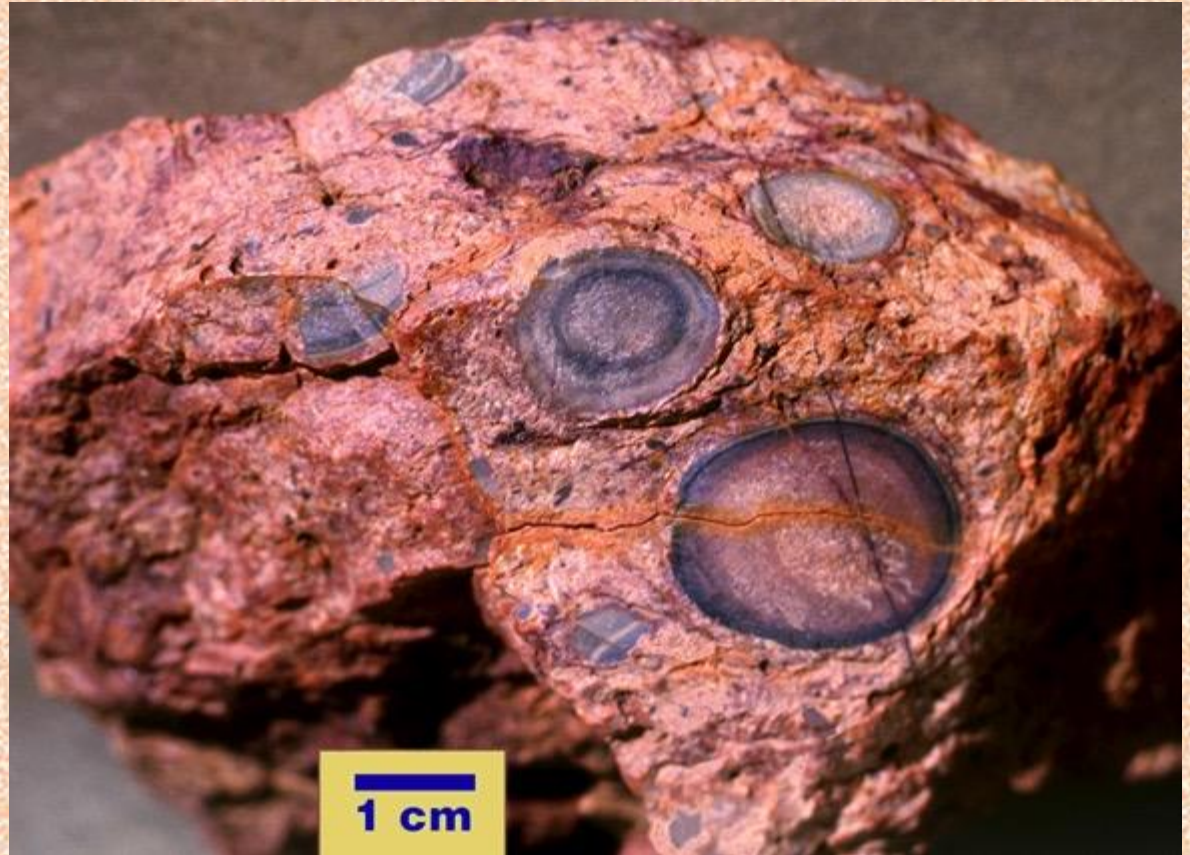


Drilling at Black Angel 1957.

**A mysterious
“porphyroid”
was found!**



An igneous origin for the Black Angel porphyroids was simply not credible. BMR geologists had called them “the pigeon’s egg conglomerate”.



Liesegang banding in chert ovoids that were identified as accretions by Professor A.E. Alexander.



After some difficulty Orlando Hole 1 found 26ft at 36dwts/ton. In great excitement Peko started digging a shaft!



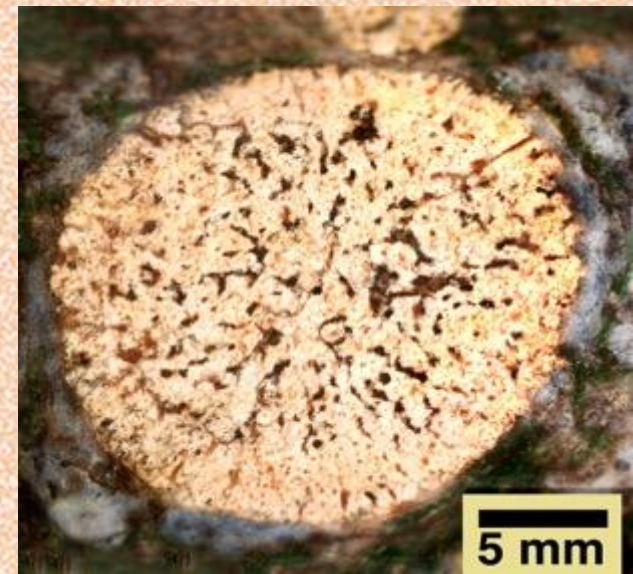
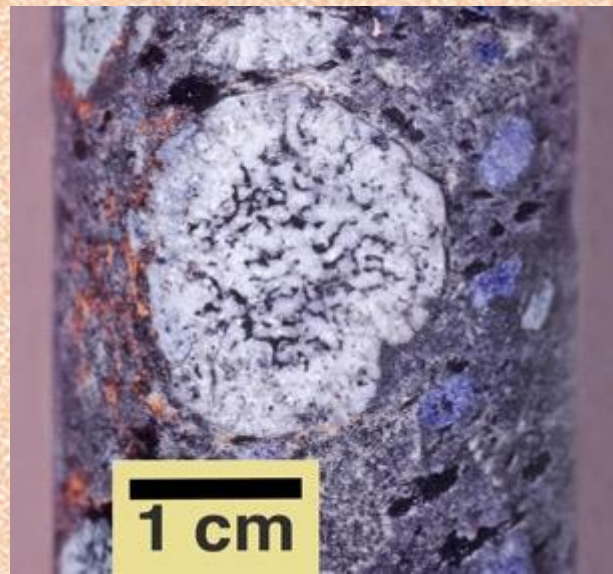
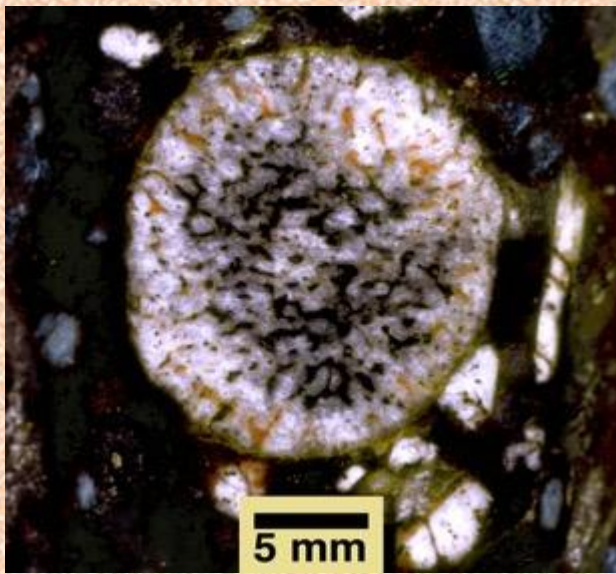


The next 7 drill holes at Orlando were negative.

After many problems underground drilling found payable gold ore at Orlando.

Production from the Orlando Mine finally commenced on 8th August 1962 just three weeks less than 5 years after the first drilling had commenced.





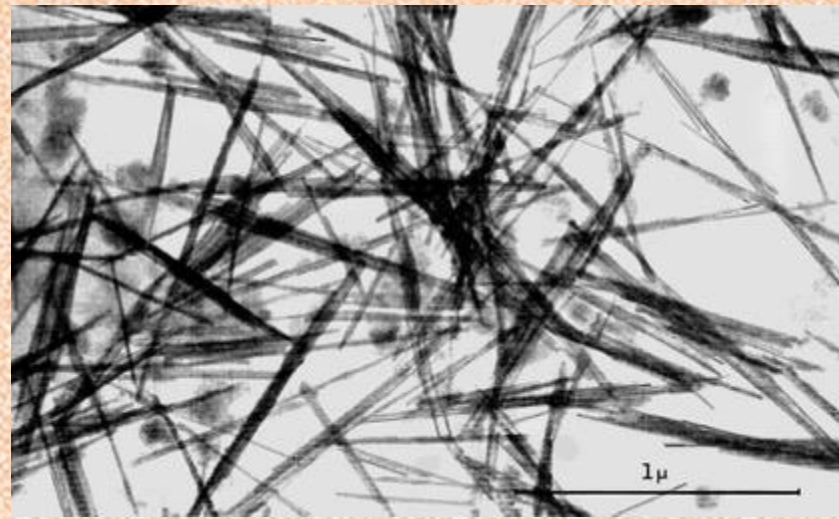
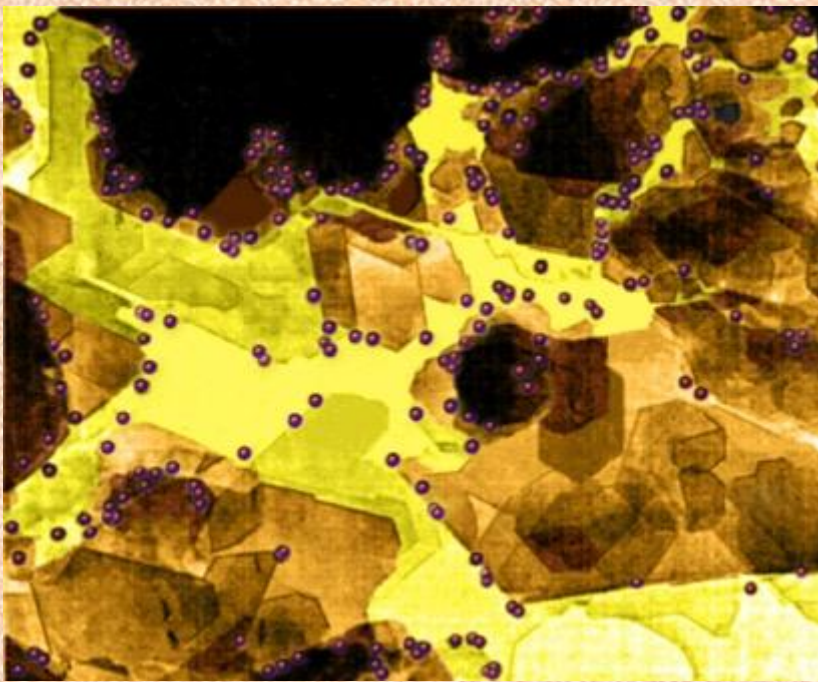
At this stage I had seen that natural clays in the mudflows and coarse porphyroids had formed accretions that had shrinkage cracks in them.

Shrinkage reduces the surfaces of clay platelets in the accretions.

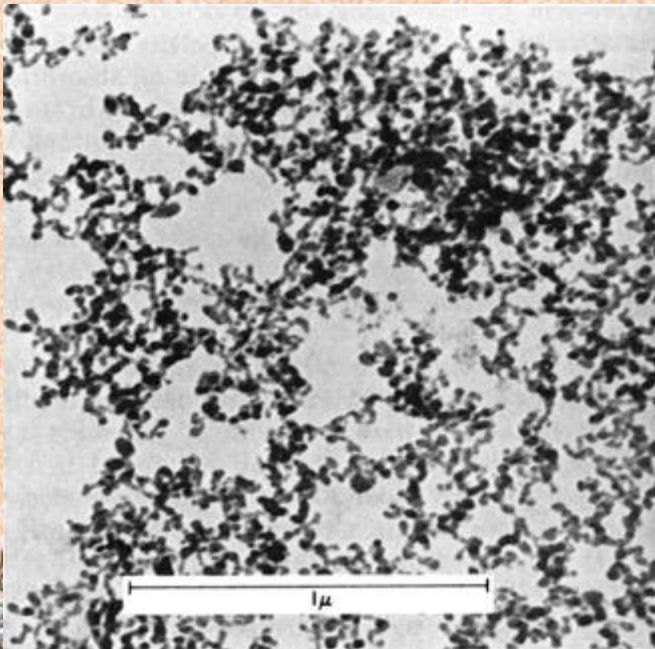
The adsorbed colloidal gold metal particles would be released.

There was good reason for me to believe the coarse Peko porphyroid was the source of gold!





I was working for Peko Mine where it was thought that reading and conferring with Professors was a waste of time!

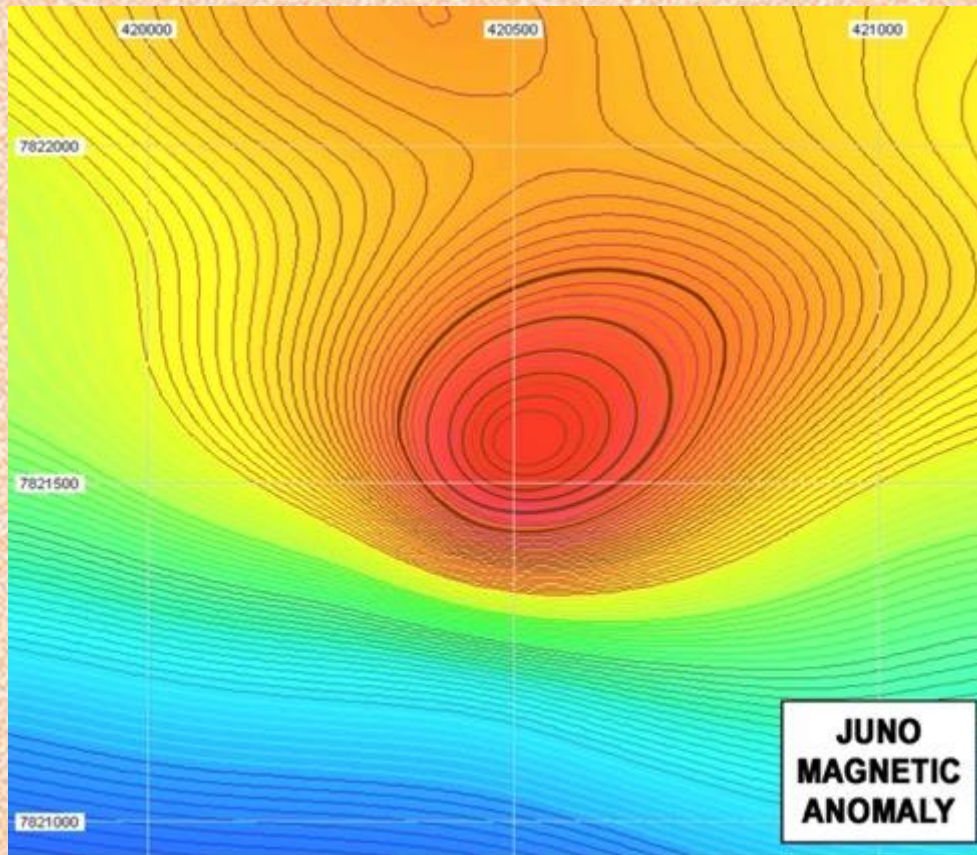


Mysels 1959 textbook on colloidal chemistry showed that clays in ordinary natural sediments adsorbed colloidal gold metal particles on their surfaces.



Every outcrop and geophysical anomaly in the Peko area were carefully mapped to find out where the ore source rock went!





**The Explorer 8
magnetic anomaly
was beautifully
symmetrical.
It clearly indicated a
buried magnetic body
centered at 600ft depth.**



Geopeko had greater freedom of exploration decision making. It enabled drilling to continue on the 'dud' Explorer 8 prospect.

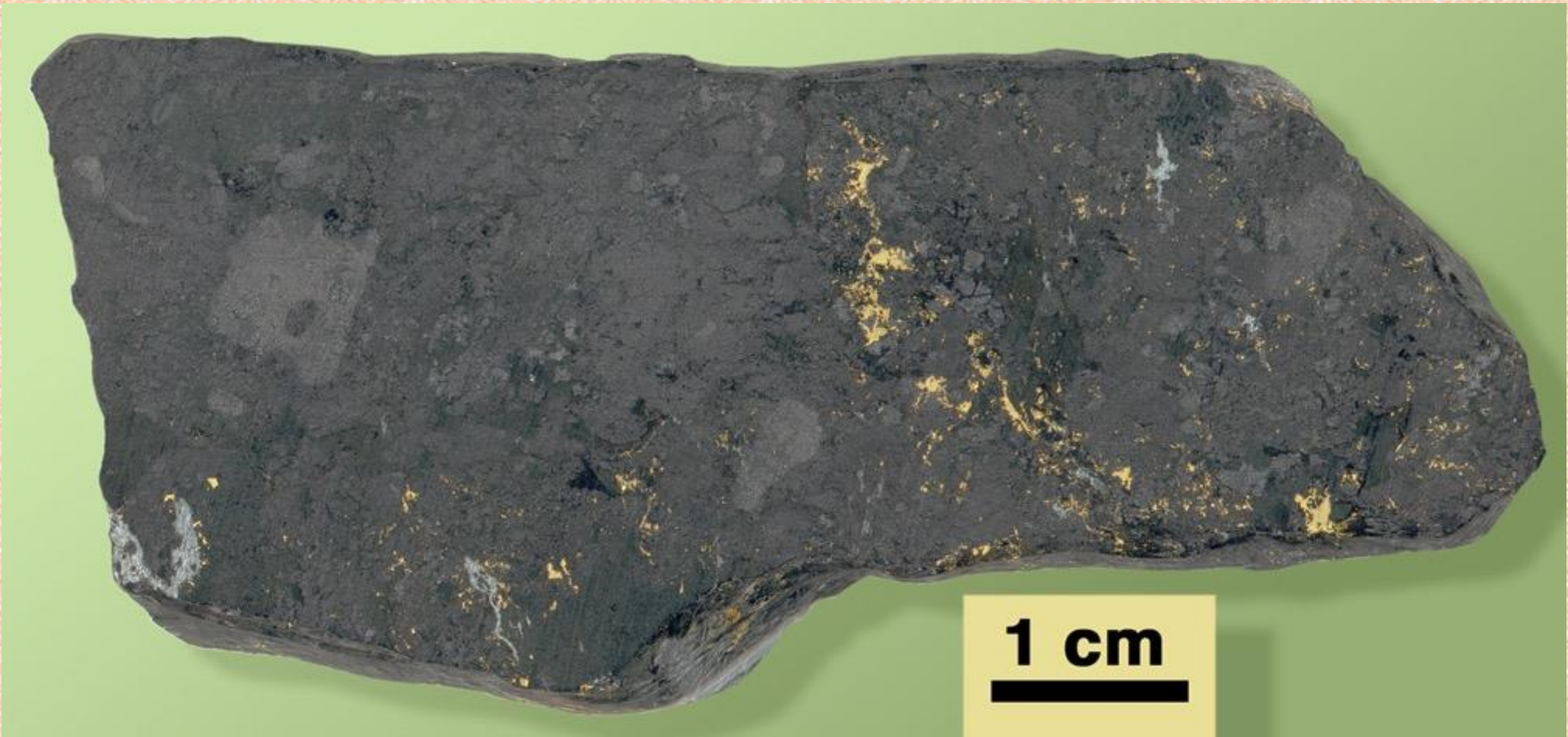
This had three negative drill holes in it but it was situated over the coarse Peko porphyroid gold source rock. I purchased the lease and drill core for £50 and persisted with drilling despite very strong opposition. Lew Richardson wanted his magnetic modelling tested.





**Juno Mine, Tennant Creek, N.T. Produced 838,941ozs of gold (about 26.1 metric tons)
It was discovered in February 1965. Production commenced in March 1968.**





Juno Mine gold ore was from one of the richest small gold mines in Australia!

346,235 tonnes at 73 g/t gold and about 1% bismuth.





**We went on to find five new mines in the first fifteen prospects drilled!
This is where the Warrego Mine started!**





The Warrego Mine was the largest (and richest) mine that Geopeko found on the Tennant Creek field. Produced 859,952 oz of gold.





Gold was pouring out of the Warrego Mine in 1977!

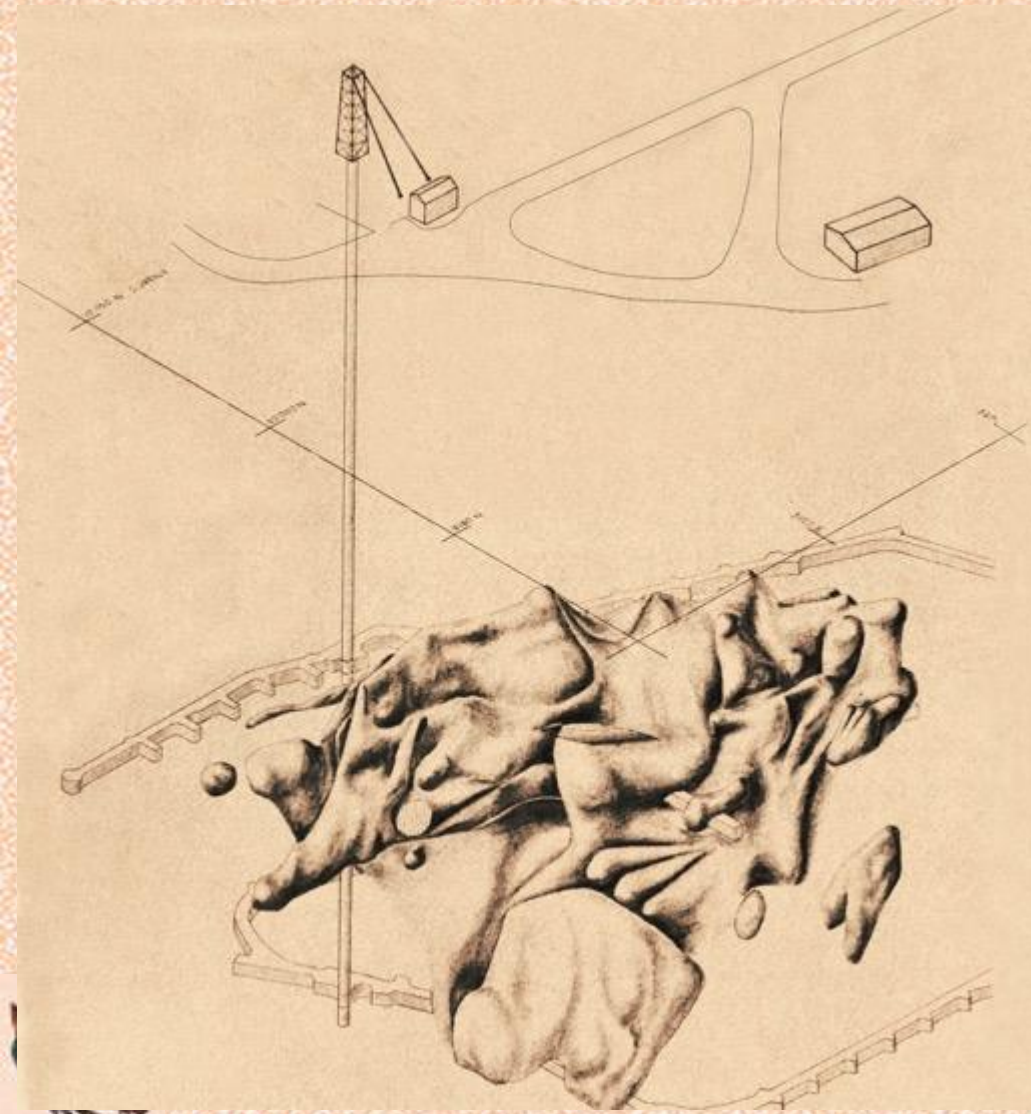


Geopeko found three more mines at Tennant Creek



Gecko Mine Tennant Creek

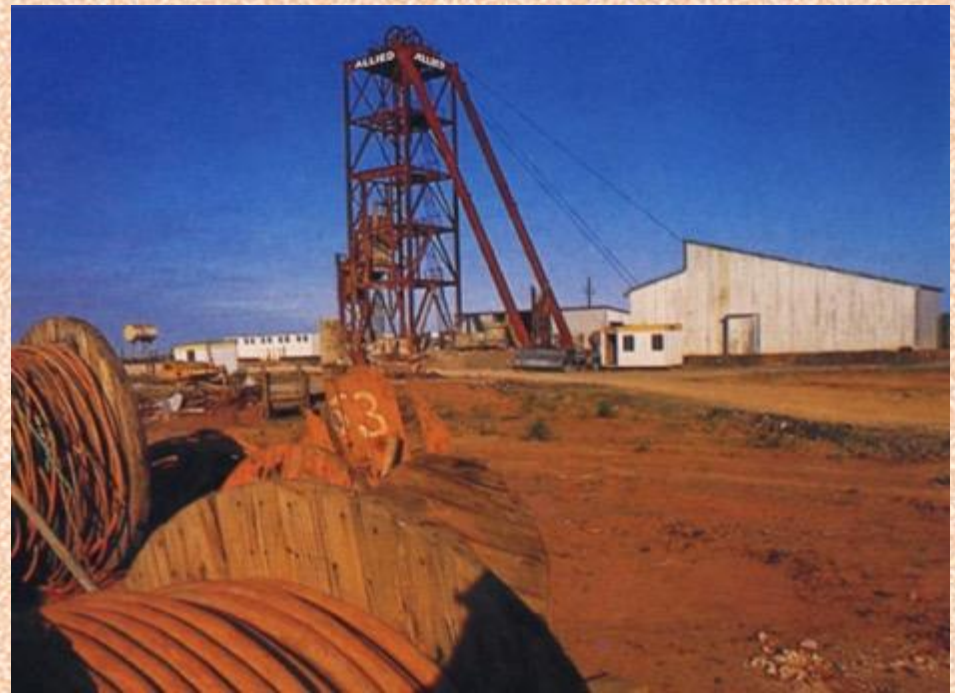
- In 1959 Gecko was pegged as Explorer 1
- 1st drilling 1960
- Movable resource indicated 1970
- Stope design 1973
- Gecko Mine production began 1975





Ivanhoe Mine

- ore grades intersected Sept 1961
- decision to mine May 1963
- production December 1964



Argo Mine

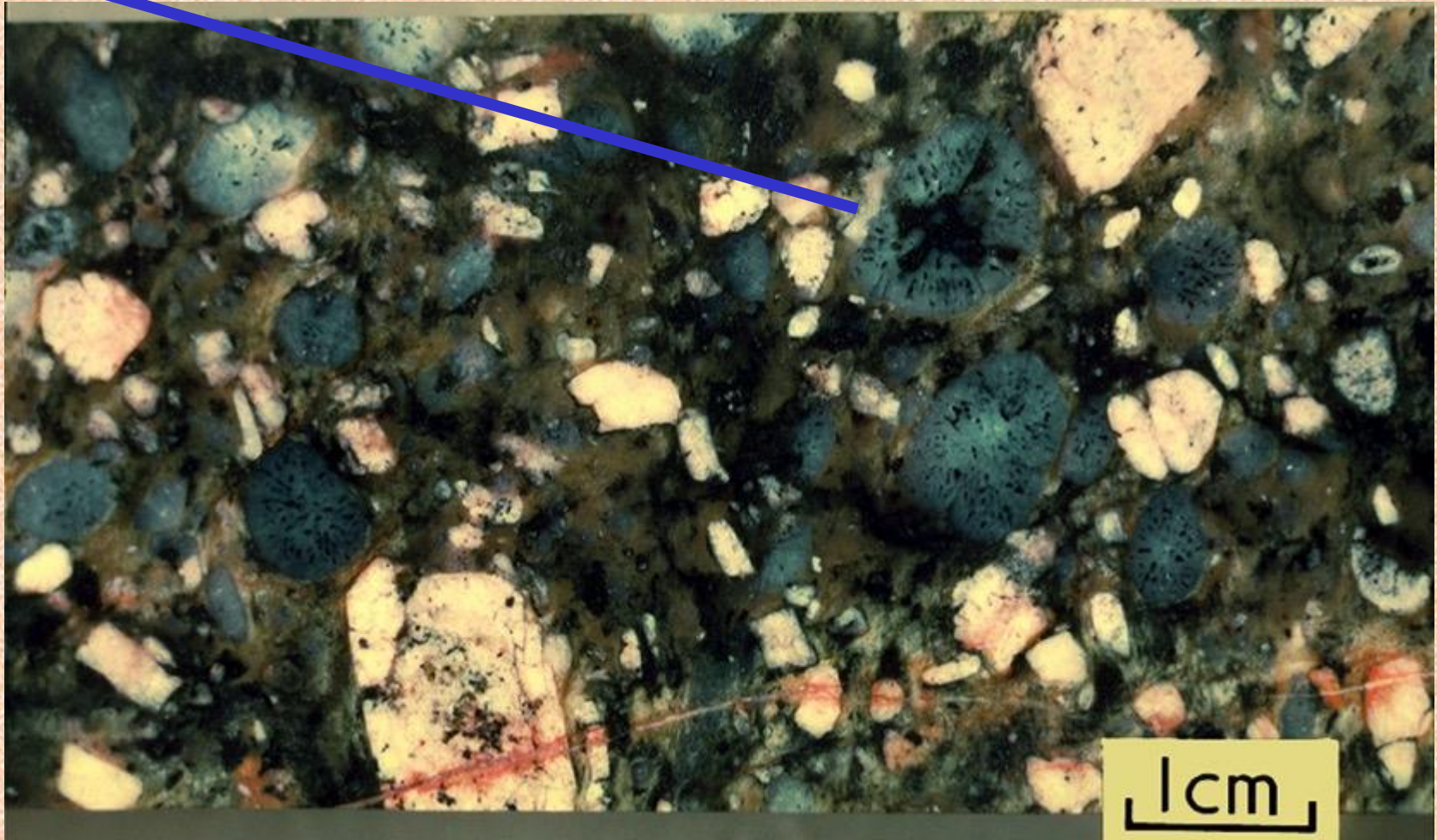
- Explorer 46 surveyed and scheduled for drilling 1967
- first ore intersections 1970
- drilling resumed 1974
- positive intersections 1980
- resource established 1982
- Argo production 1983



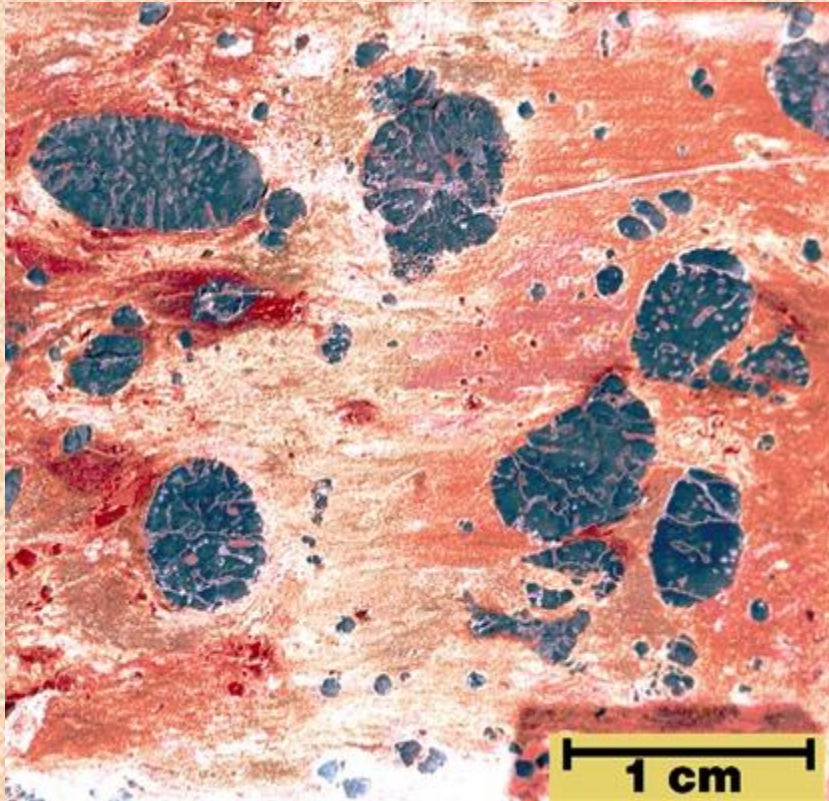
But what were the Tennant Creek porphyroids?

Could they be igneous “phenocrysts” with
feldspar/quartz contacts like this?

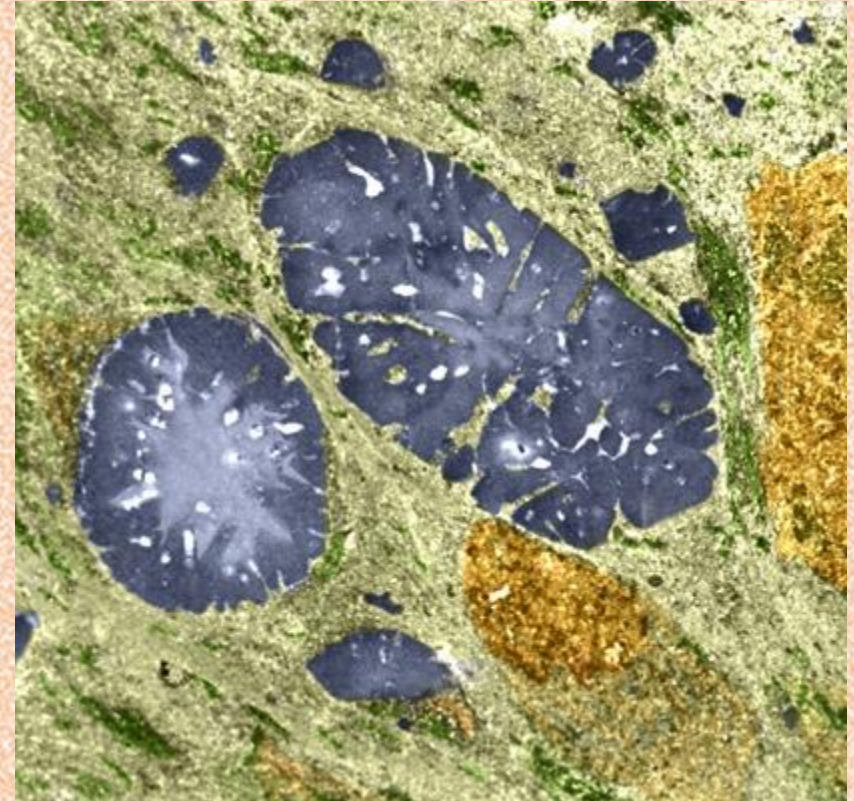
Prof. Alexander had said they were accretions.



The porphyroid quartz ovoids contained shrinkage crack patterns that we now know to be due to syneresis



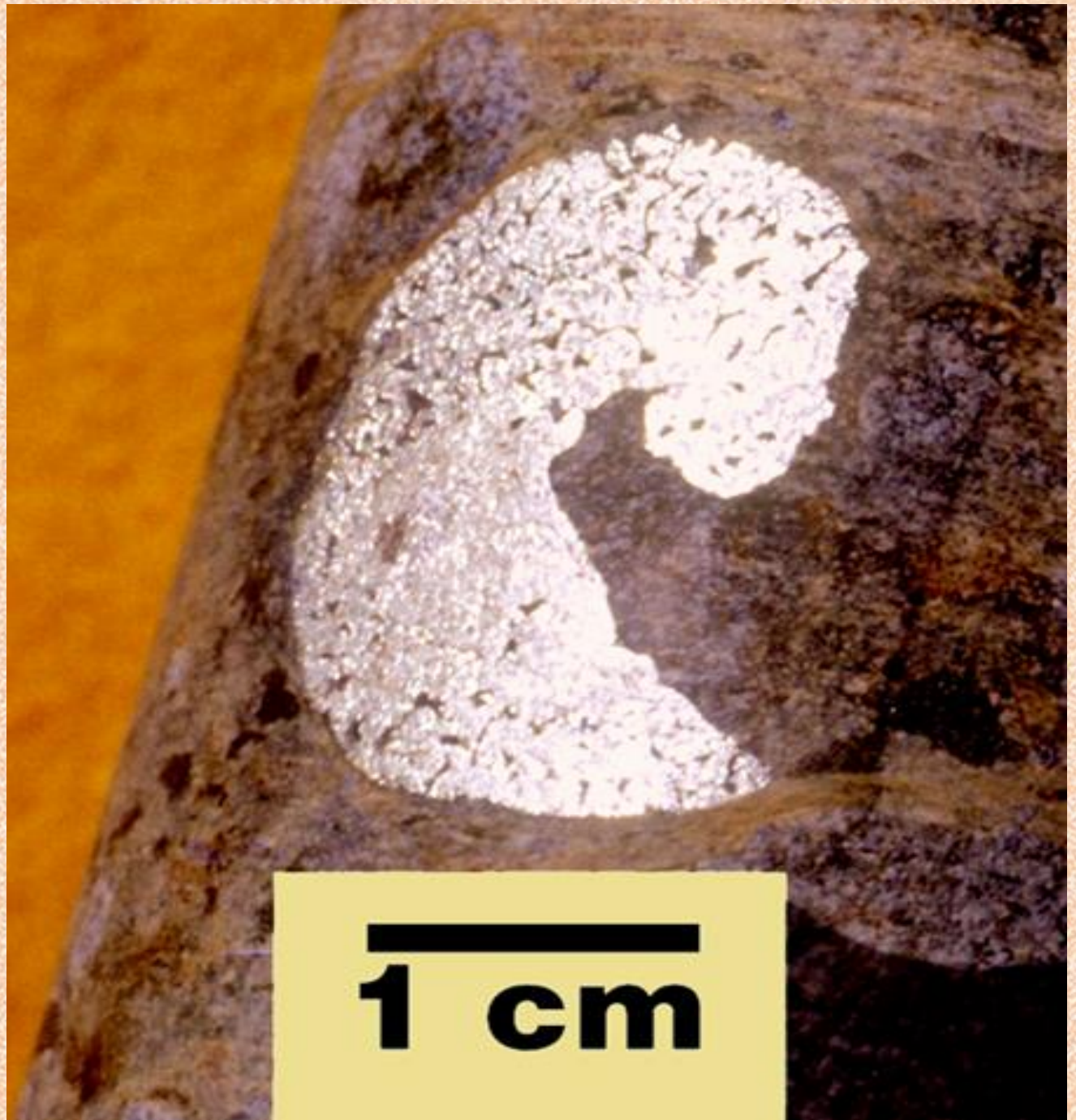
From the formerly fluid mud between breccia blocks in the True Blue mud slide complex at Tennant Creek, NT

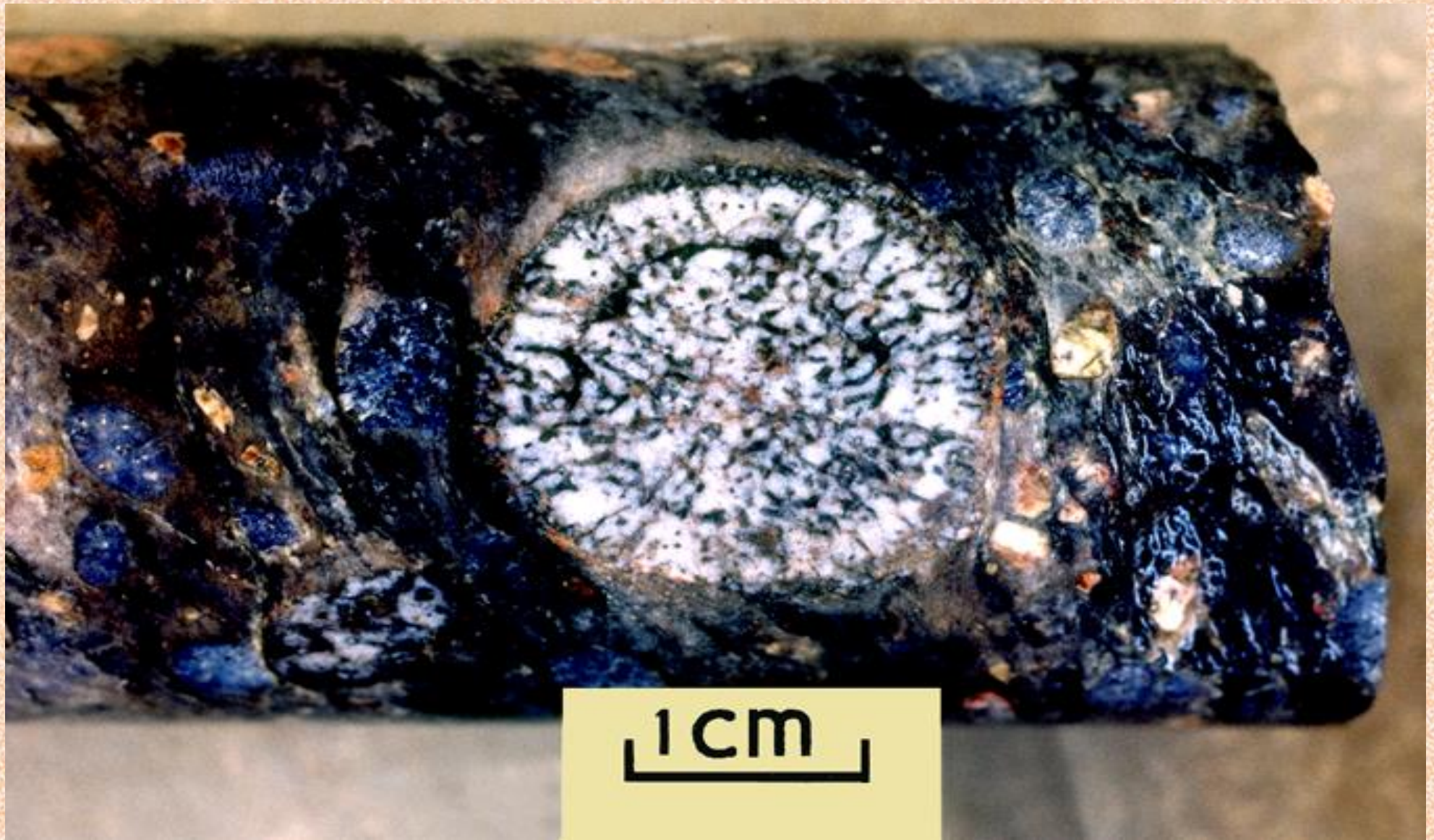


From a sericite-chlorite rich (muddy) part of the Great Western porphyroid at Tennant Creek, NT



**Tennant Creek
porphyroid
feldspars to
show that they
were formerly
plastic!**

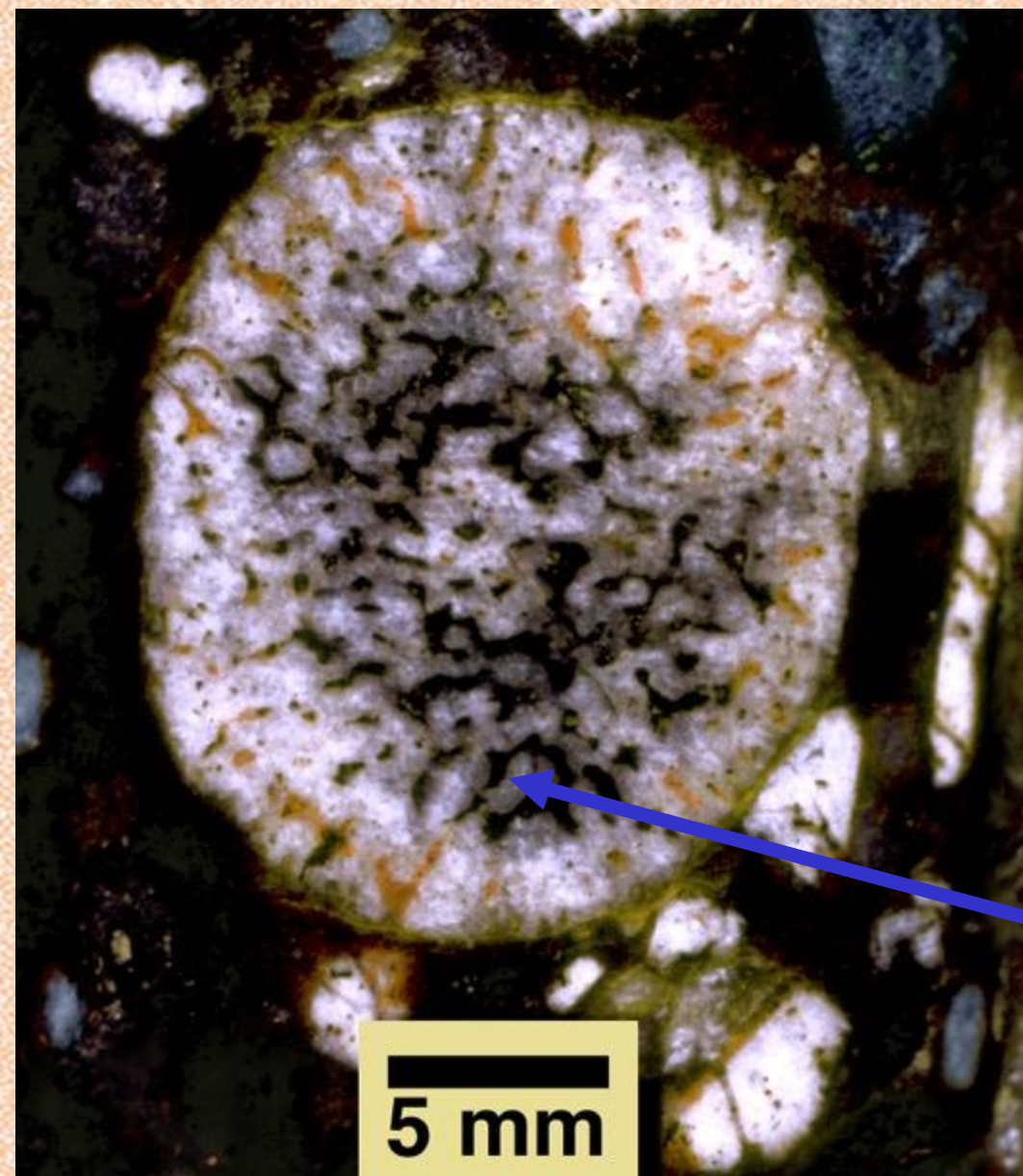




Most feldspars were rounded and contained mysterious crack patterns that were also found to be due to former syneresis.



- Some of the syneresis cracks in the Great Western porphyroid contain concretions!





The enormous power of prolonged erosion!

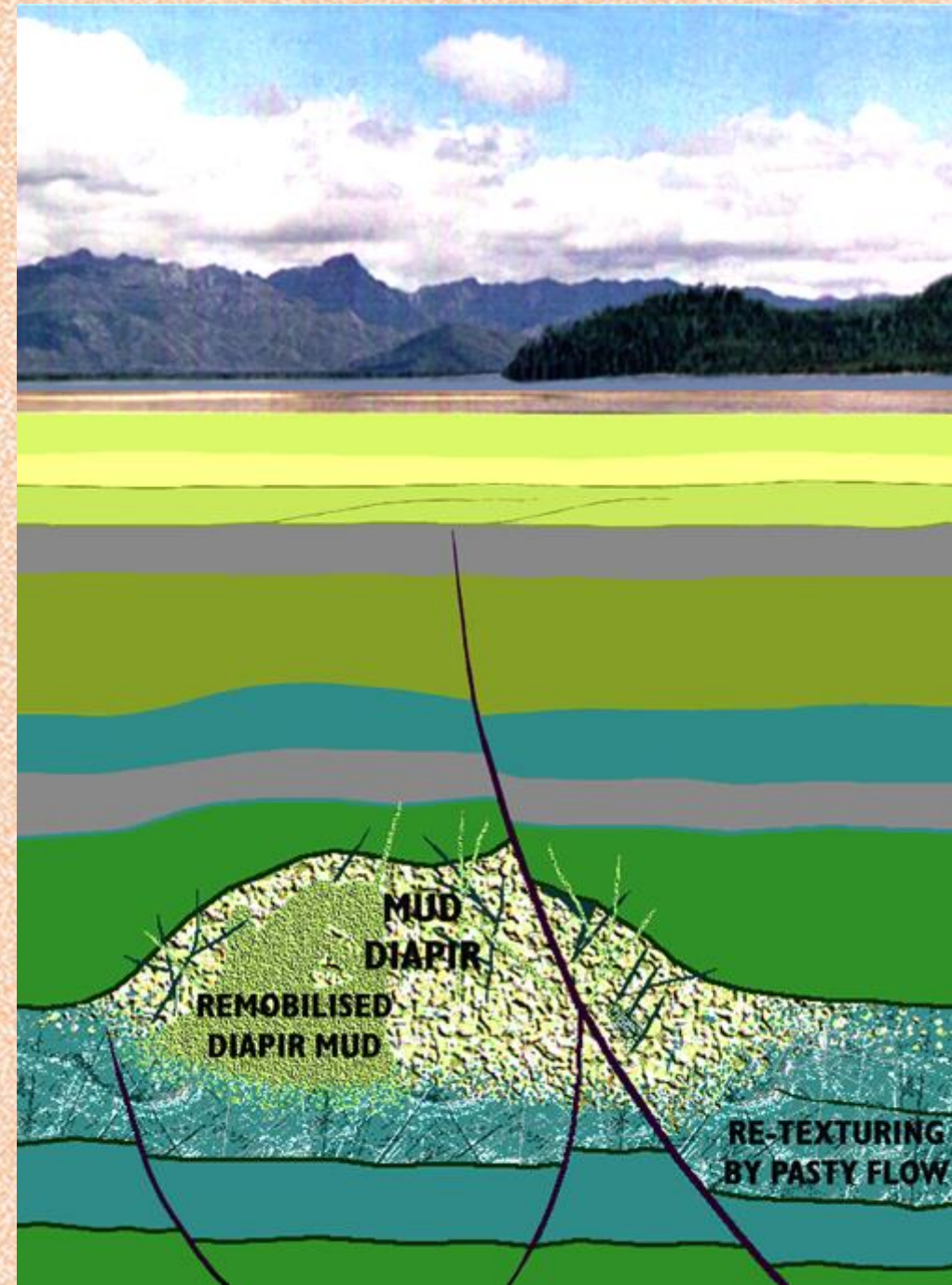
**Think of the energy inputs if we had to make
such cavernous valleys by open cut mining!**

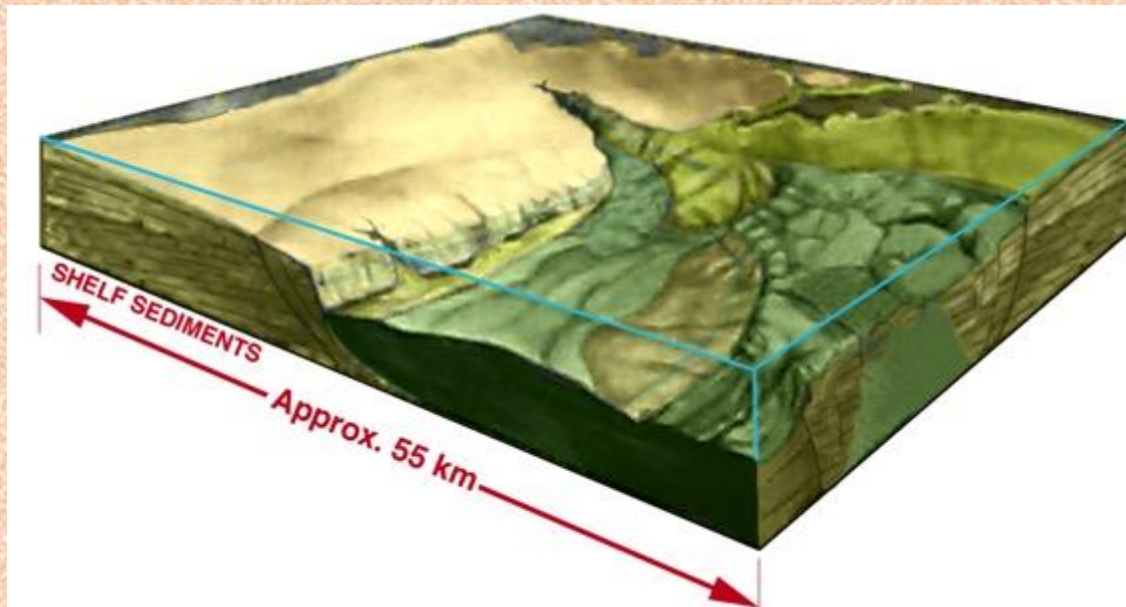
Enormous energy is required to **grind the rock** minerals to mud particles plus the **chemical energy** of weathering to break them down to clays, amorphous silica, etc.

The energy ends up in the mud!

In every cubic meter of mud the surface area of the particles amounts to about 60 million square meters.

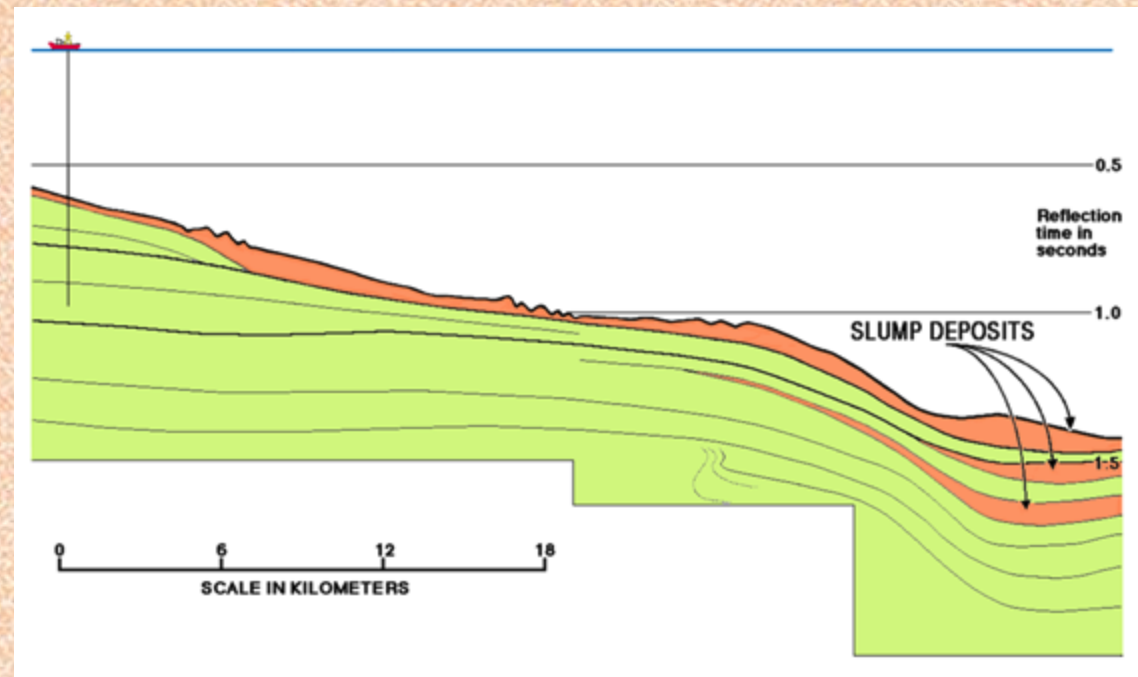
Surface energy is a significant component of the total energy.

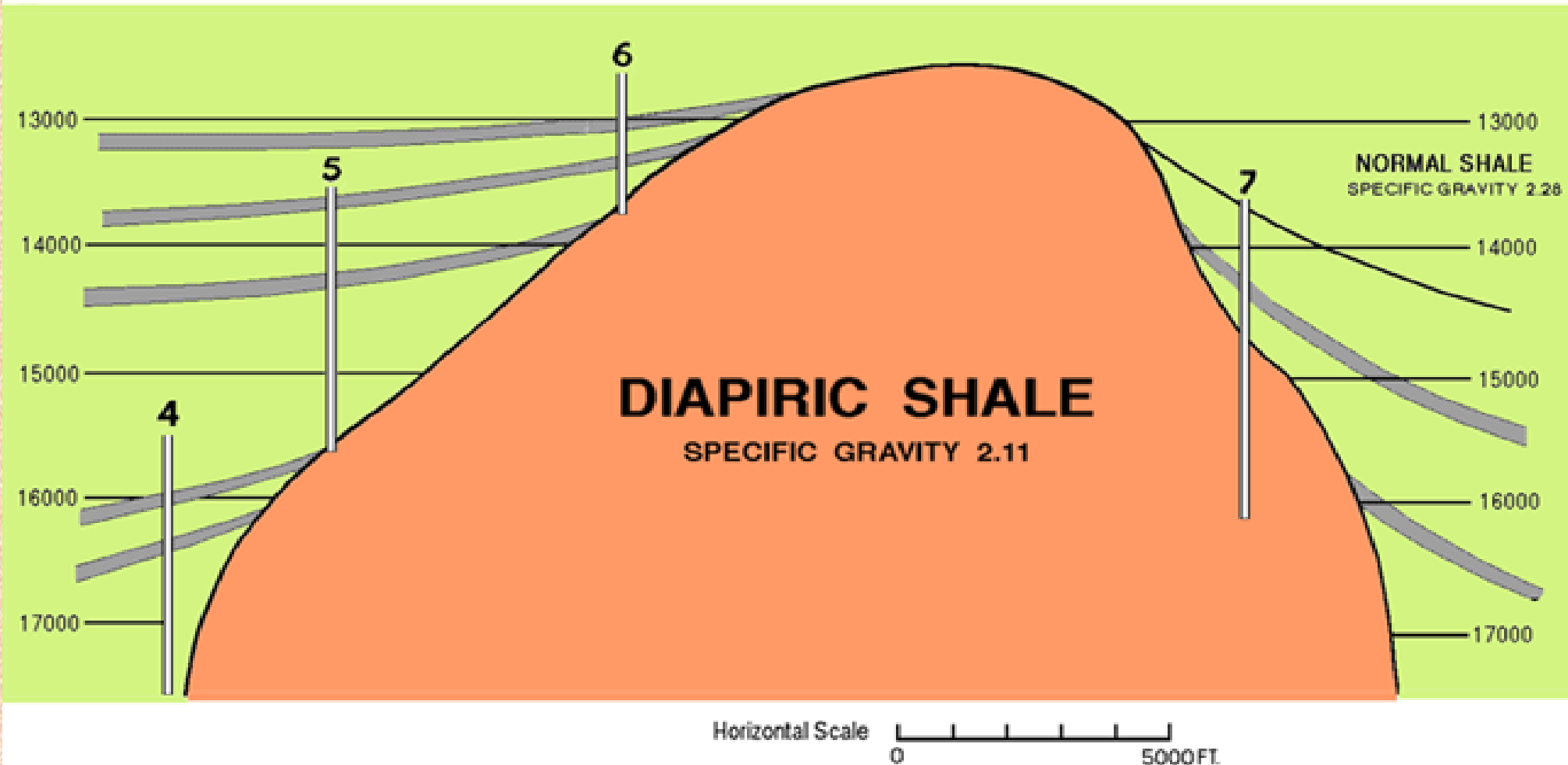




Deposits resulting from massive slope failure and erosion of shelf deposits characterise the Tennant Creek sedimentation.

To understand the geology of Tennant Creek and how the ore bodies were formed we had to study turbidites and associated mud flow deposits.



N**SECTION B - B'****S**

- Sediment diapirs rise more than 1.5 km in basin sediments.



- The behaviour of all fine grained particulate matter is governed by the surface charge on the particles!

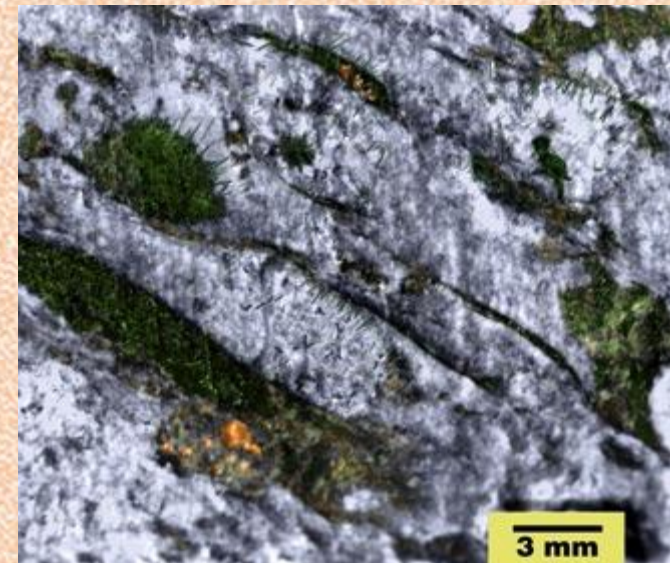
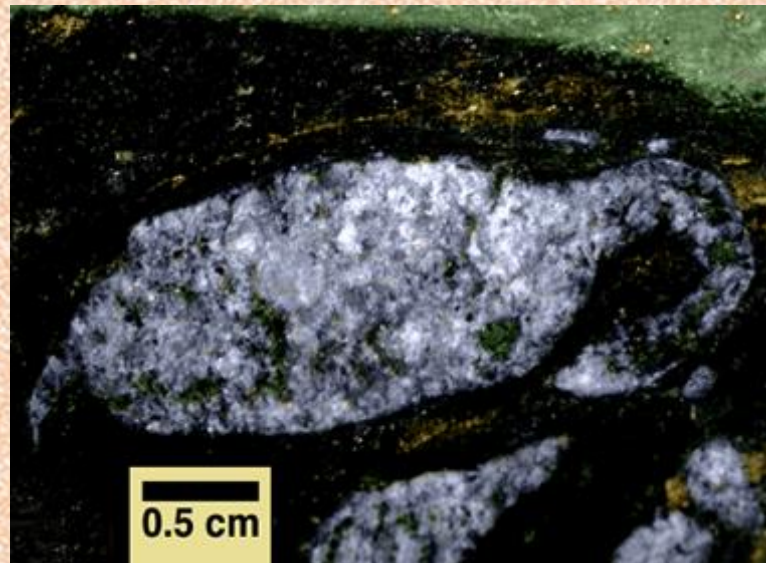
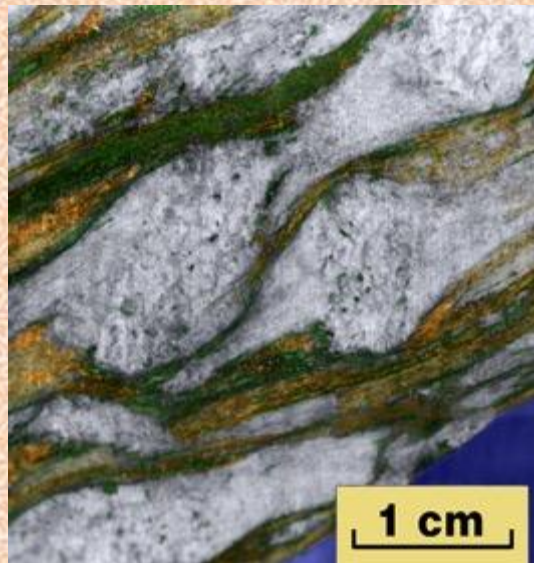
EVIDENCE OF 14 PROPERTIES OF PARTICLE SYSTEMS IS COMMONLY PRESERVED IN THE ROCKS

- | | |
|--------------------------------|----------------------------|
| 1) PLASTICITY | 7) DIFFUSION |
| 2) COHESION
AND FRACTURE | 8) ACCRETION |
| 3) THIXOTROPY | 9) CONCRETION |
| 4) RHEOPEXY | 10) SYNERESIS |
| 5) REVERSIBLE
HYDROLYSIS | 11) ADSORPTION |
| 6) ENHANCED
CRYSTALLISATION | 12) DESORPTION |
| | 13) LONG RANGE
ORDERING |
| | 14) SHEAR THINNING |



If the rocks and rock minerals were formed by crystallisation of particulate matter, we should see evidence of the properties of fine particle systems preserved in the rocks.

Former **PLASTICITY** should be recognised by everyone.

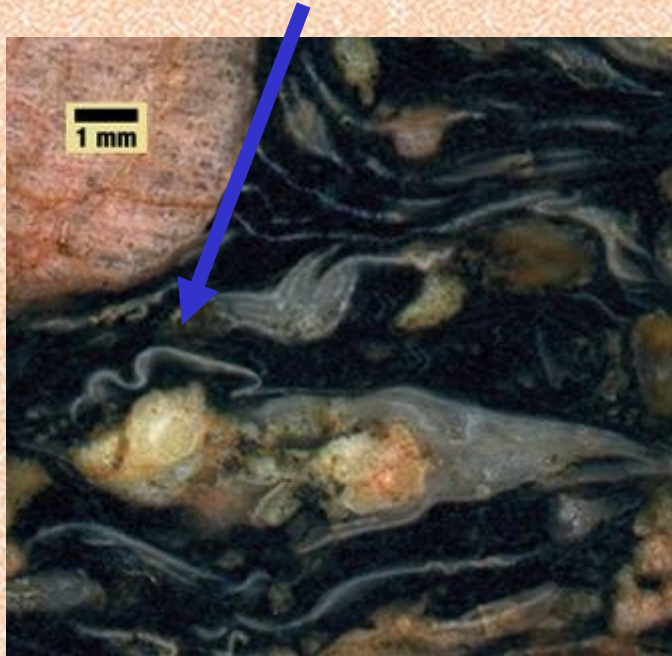


Plastically deformed quartz “phenocrysts” in the Great Western porphyroid at Tennant Creek. NT.

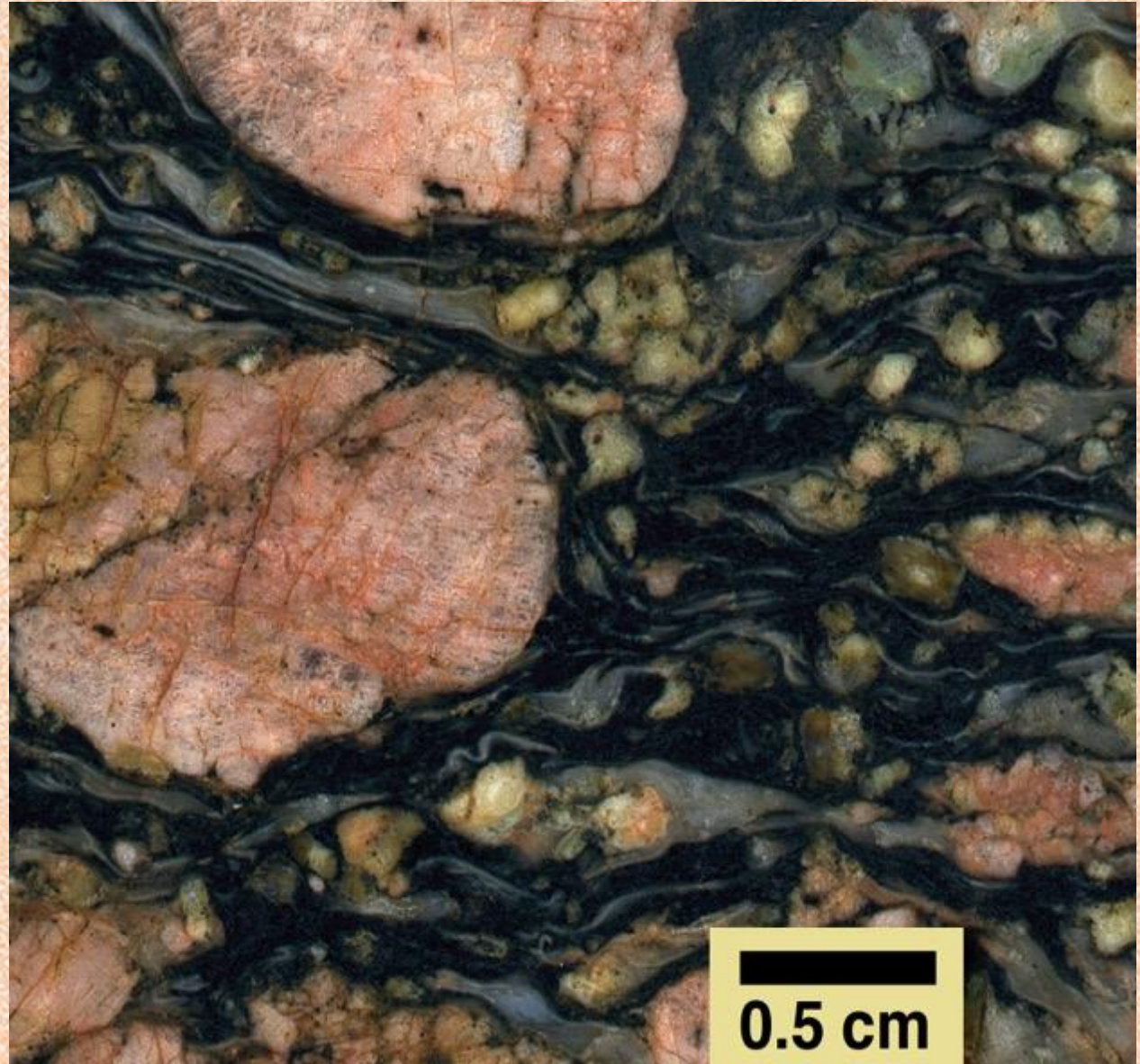


Academic geologists have not addressed this problem since Sederholm raised it in 1928!

Do you think deformed quartz “phenocrysts” in this Tennant Creek granite look as if they were once plastic?



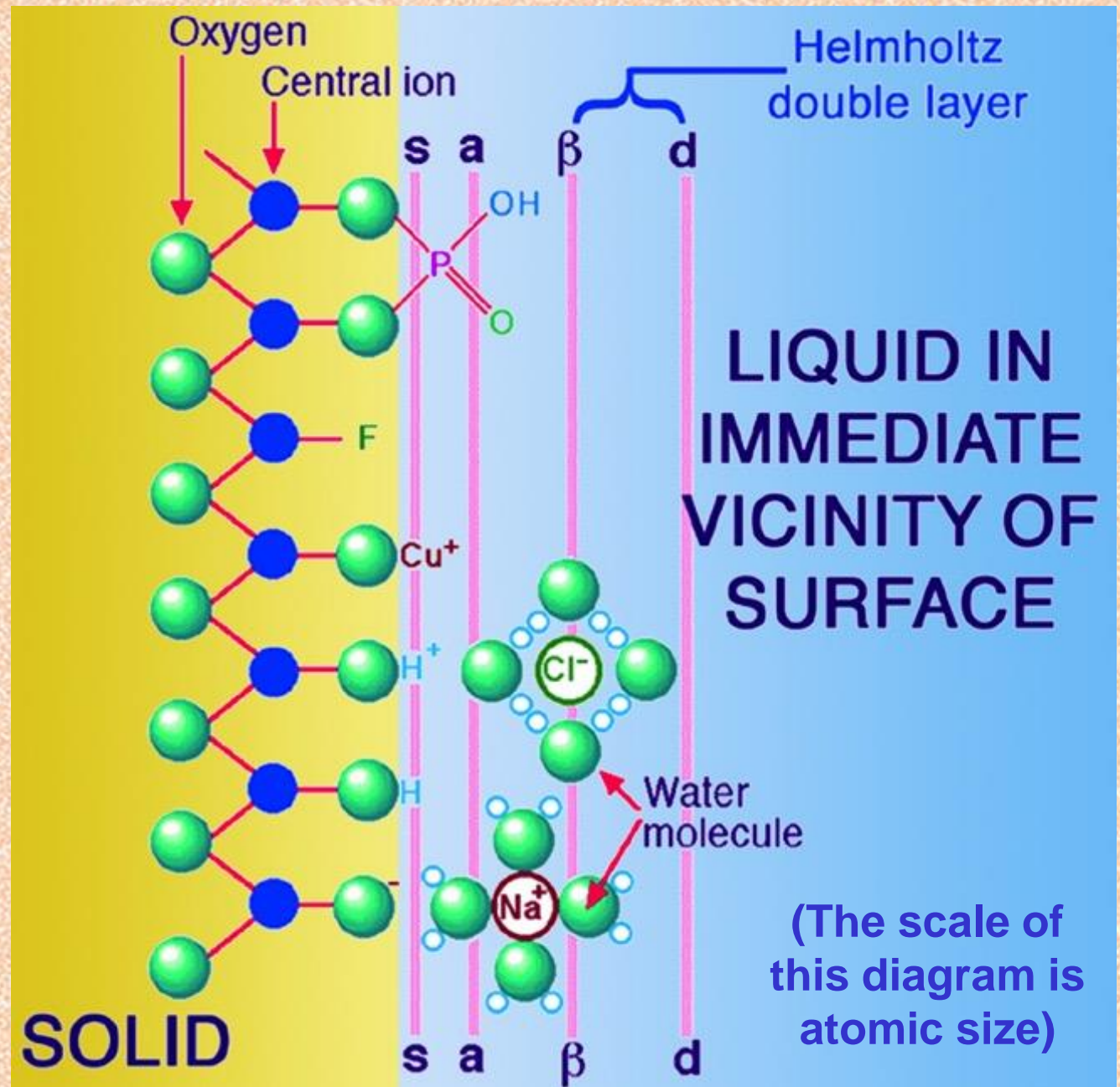
How would plastic quartz originate by melt cooling?

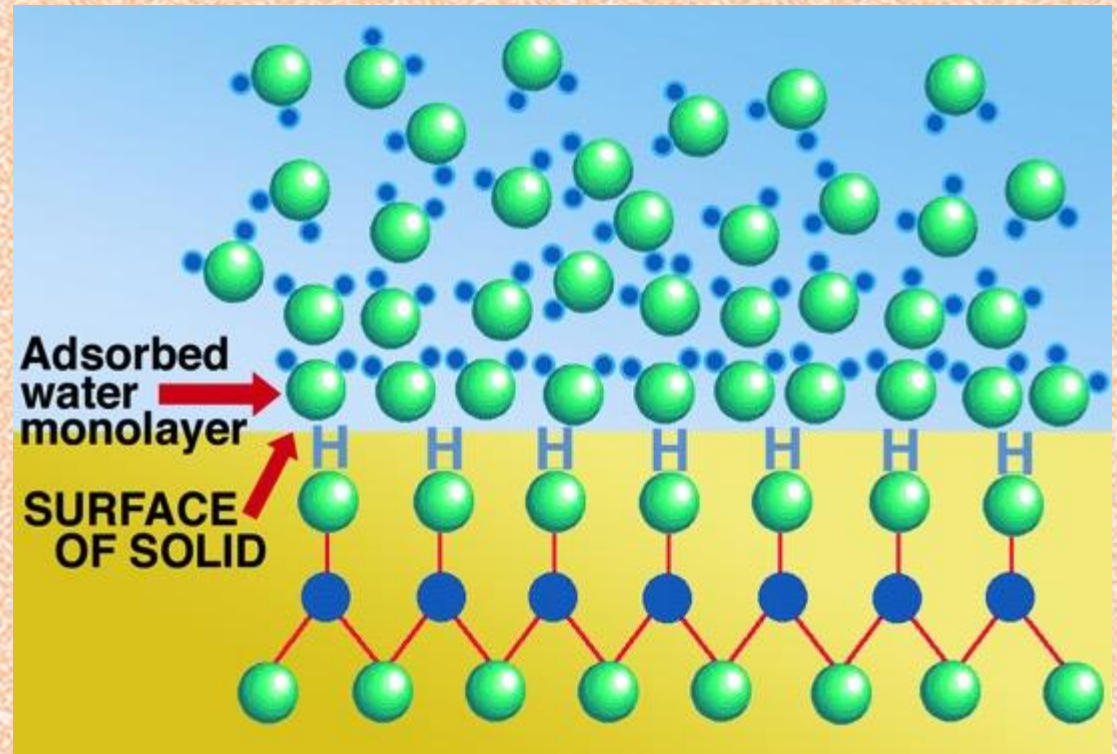
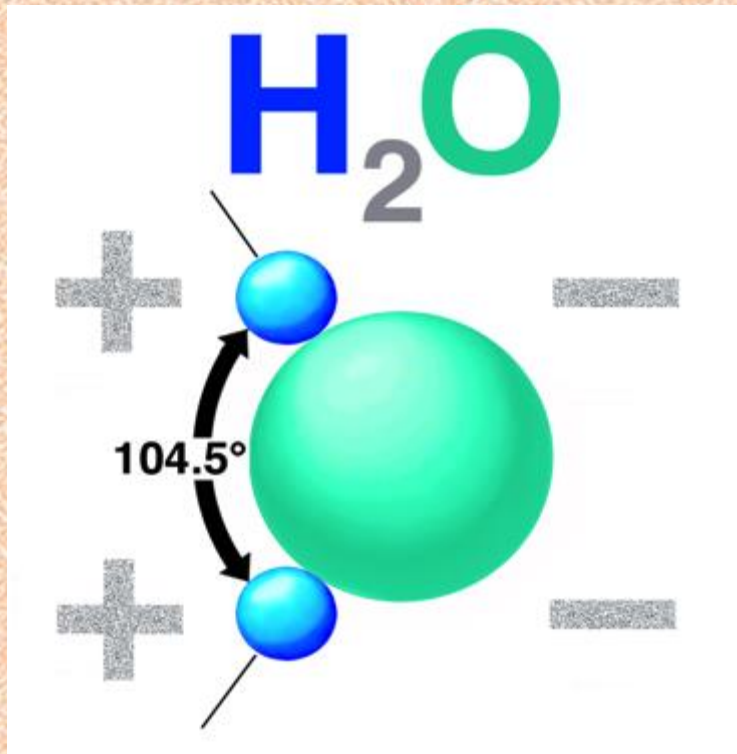


- All chemical reactions that occur in inter-particle spaces of fine-grained sediments during diagenesis must take place in the immediate vicinity of a surface.
- Hydrothermal solution theories are based on normal chemical reactions established for bulk solution such as those in open test tubes or laboratory reaction vessels.
- The presence of charged surfaces at the scale of the reacting ions and molecules is the essential difference between what actually happens in nature and “hydrothermal solution theories”.



SURFACE CHARGE CONTROLS THE CHEMISTRY AT A SURFACE





The polarity of water molecules enables them to “wet” the charged surfaces of sediment particles as an adsorbed water monolayer.

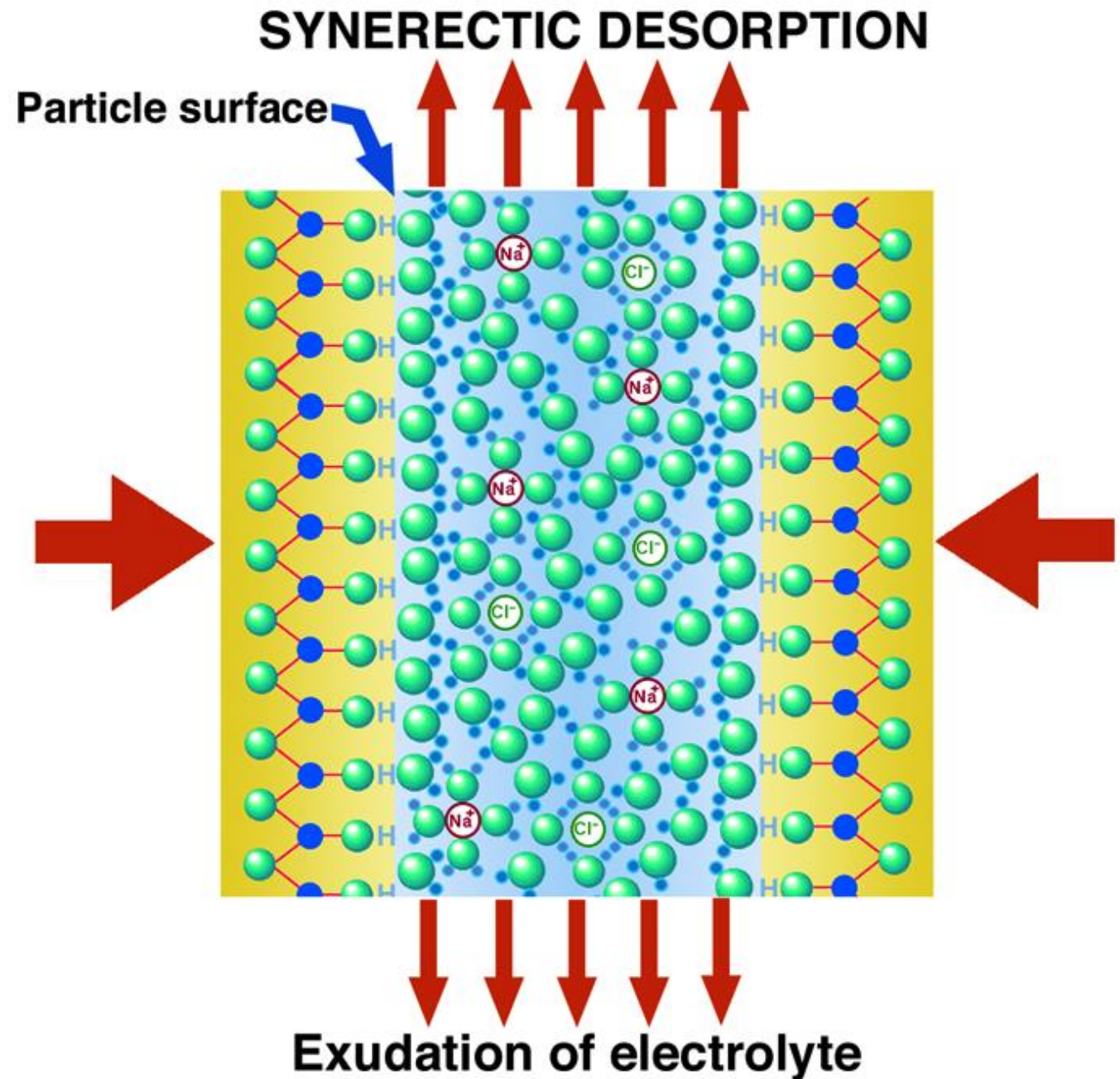
(all 60 million square meters of particle surfaces in each cubic meter of marine mud!)



Syneresis

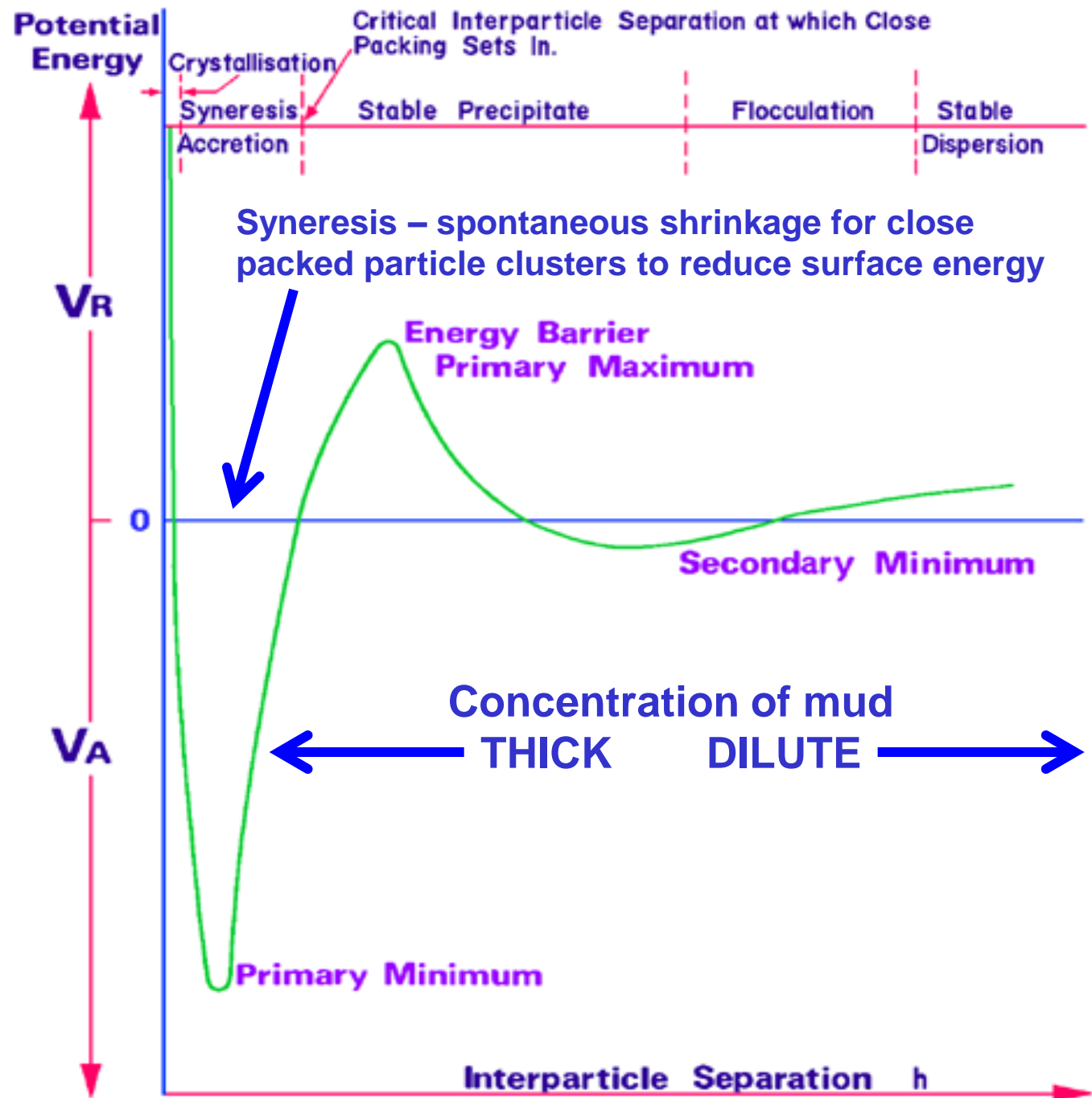
“squeezes out”
the fluids.

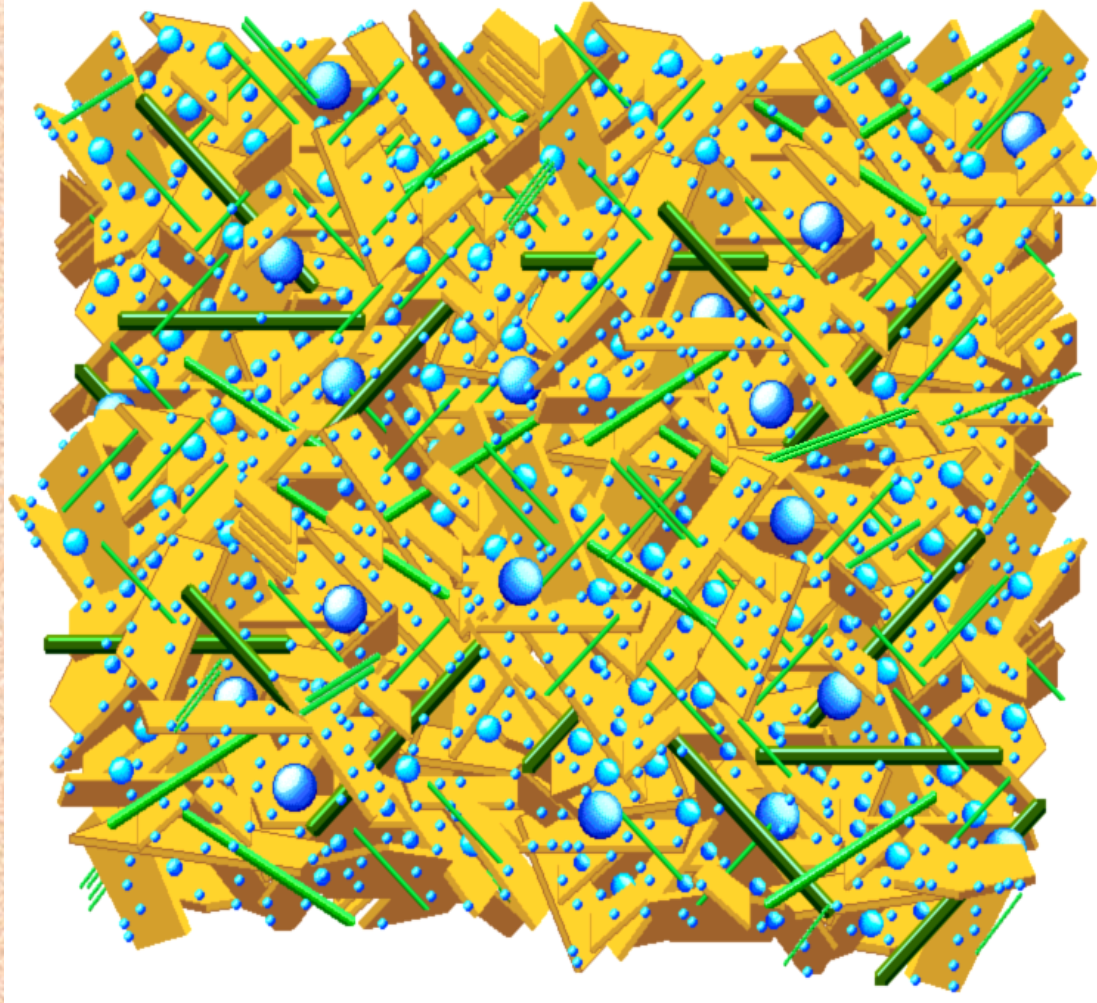
(increasing
concentration of
brine in the
interparticle
spaces displaces
anions, cations
and charged
particles.)



DLVO theory has now been confirmed by measuring the forces between charged particles with an adapted atomic force microscope..

During the flow of concentrated pastes, similarly shaped charged particles “lock on” to each other to form close packed accretions.

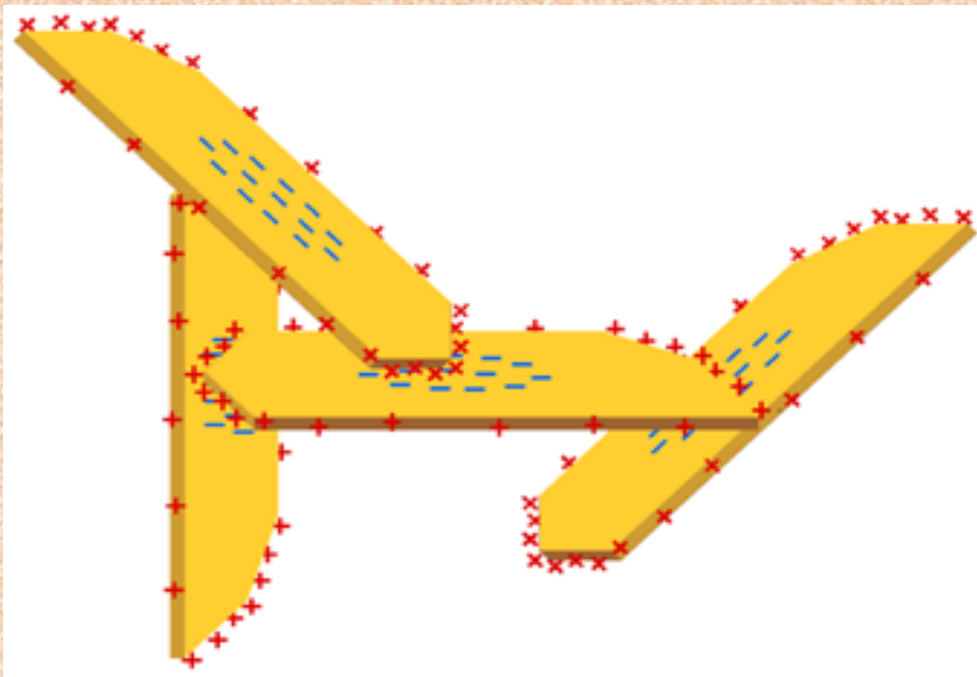




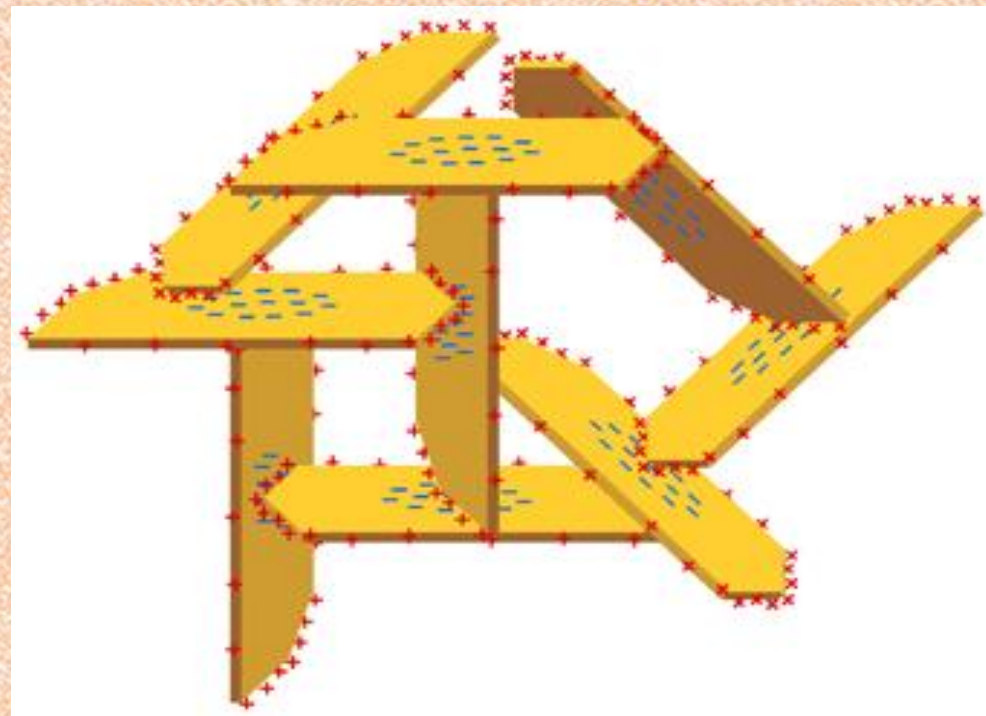
**The upmarket
name for mud -**

**“A heterogeneous
macromolecular
mixture of
inter-acting high
energy particles.”**

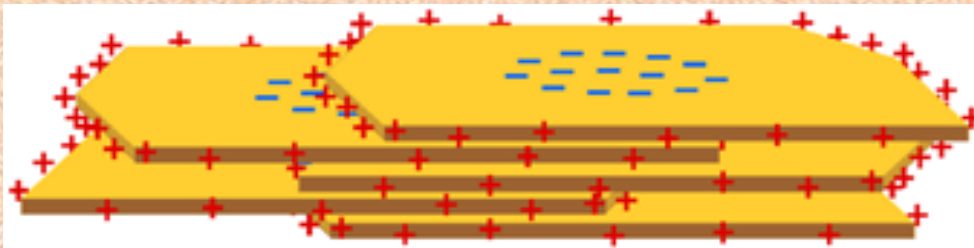




- Simple clay floc

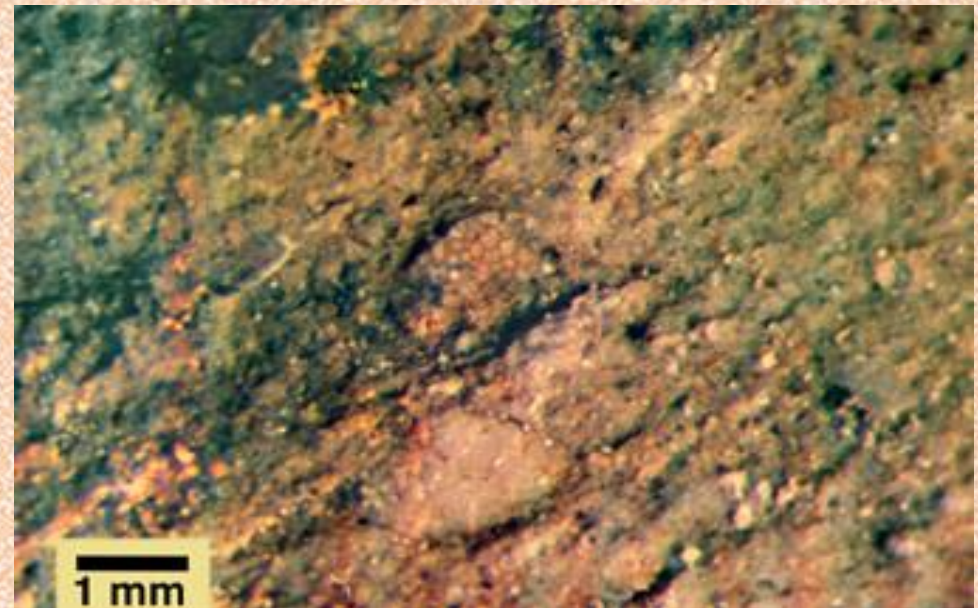
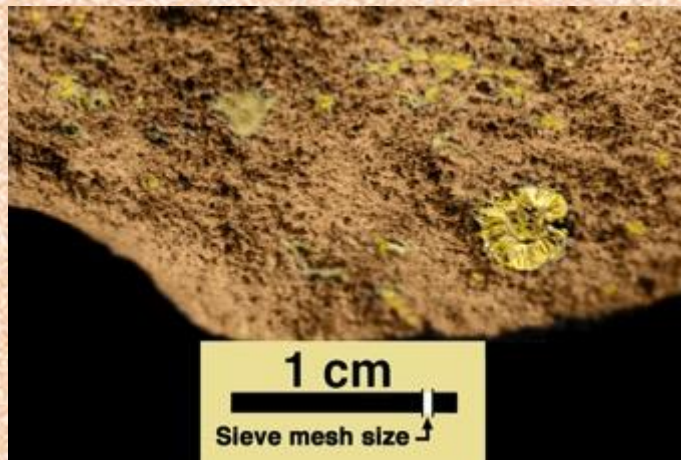


- “House of cards” structure



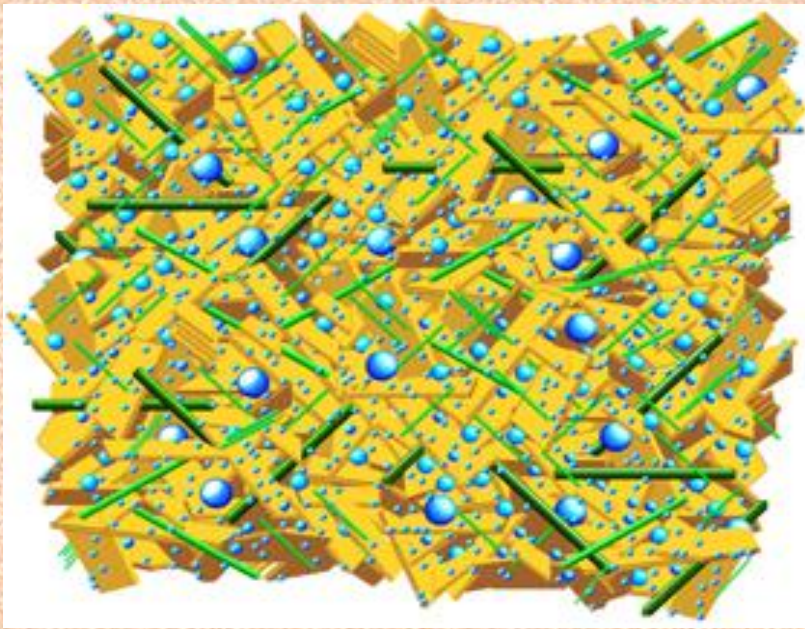
- “Book” structure -
double satisfaction of surface charge



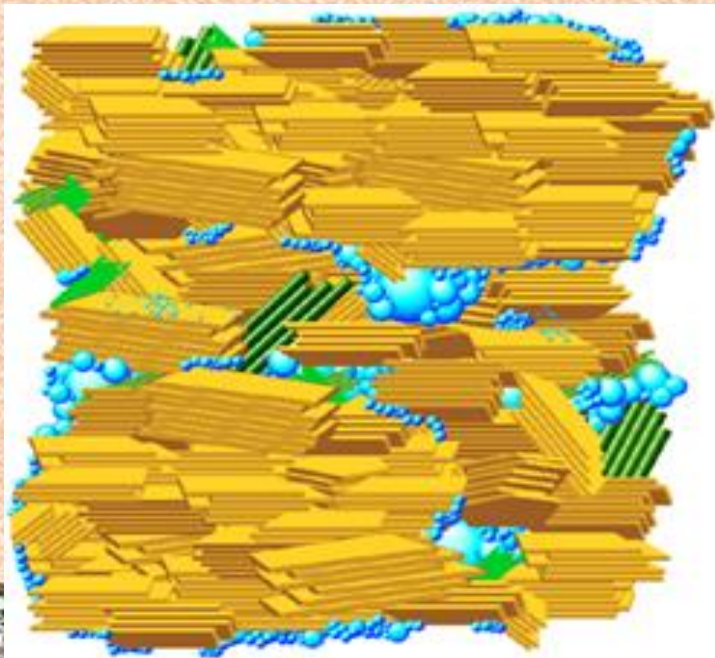
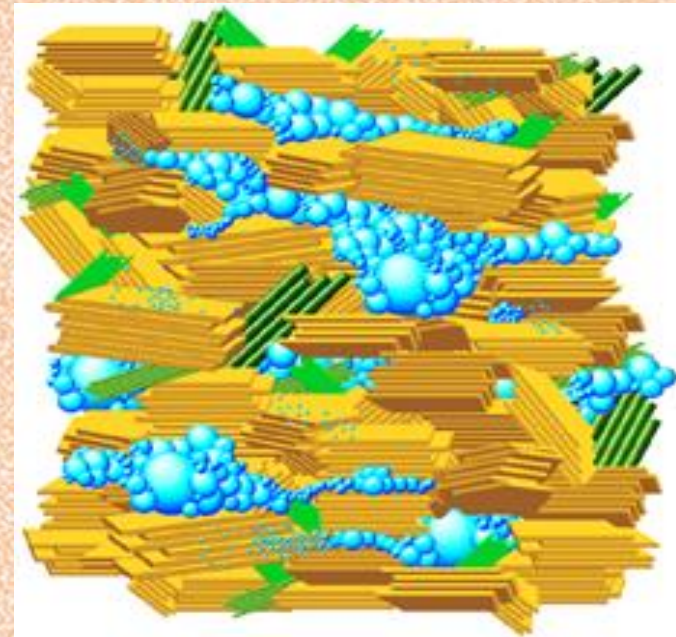


Accretions
can be
made in
clay-rich
mud!

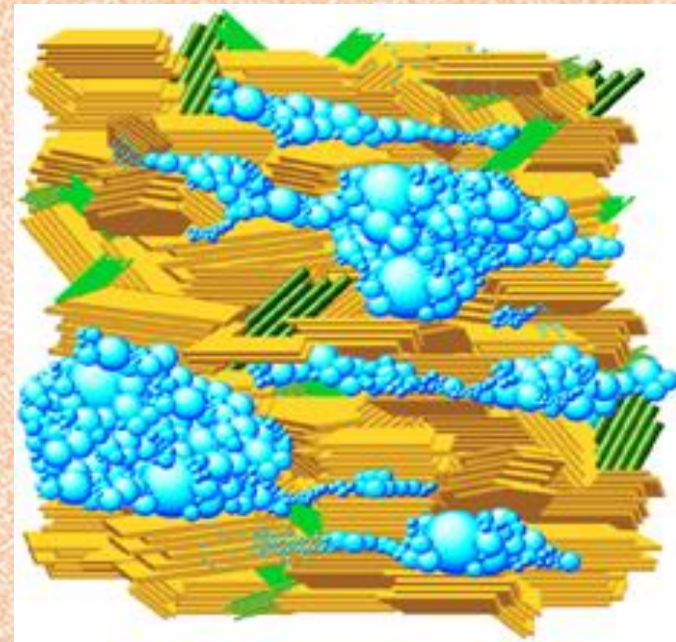


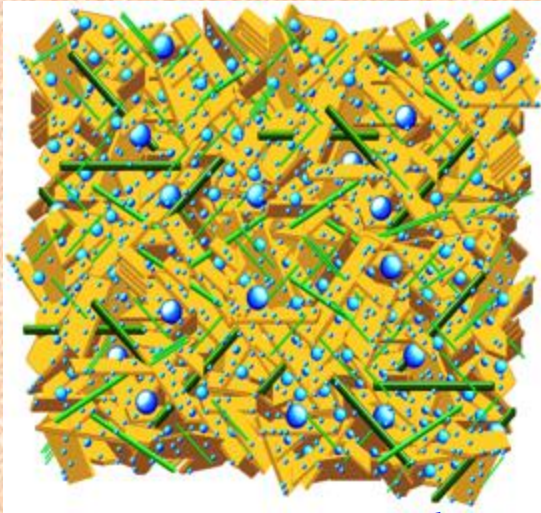


Liquefaction and flow as a paste shears the original mixture of charged particles.

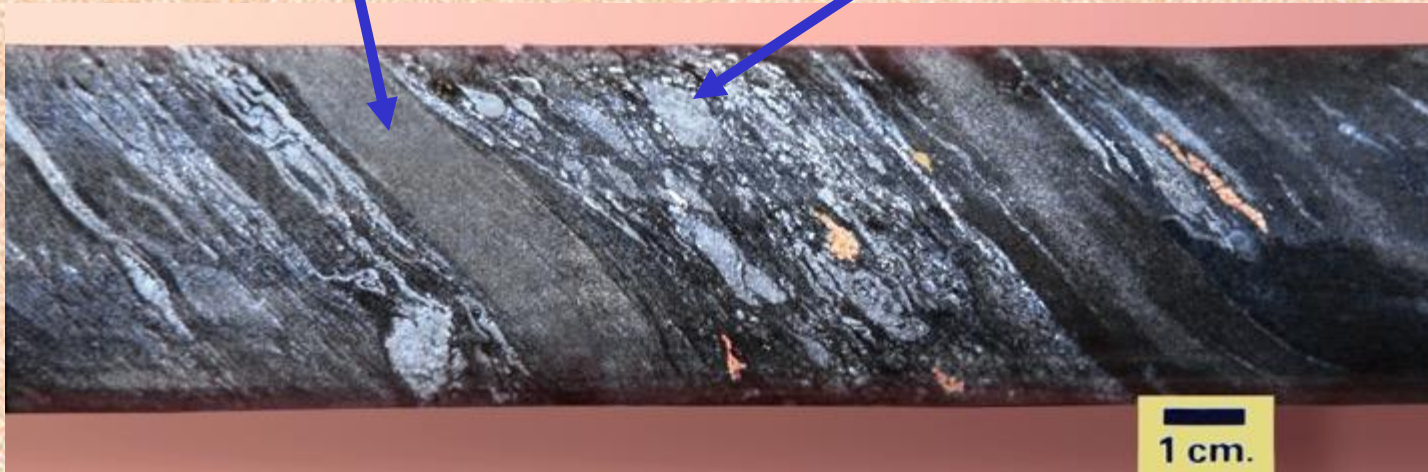
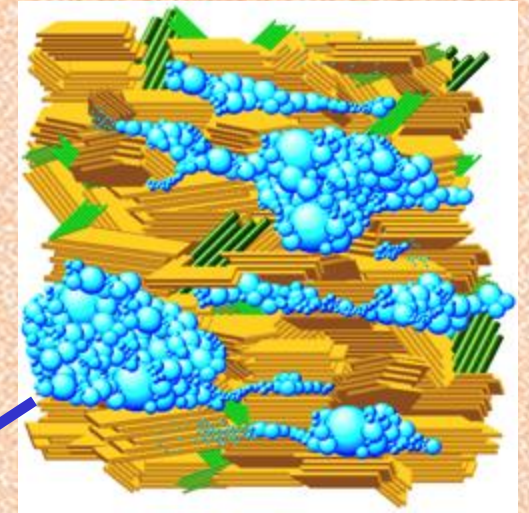


The particles form coherent clusters which aggregate into larger accretions during viscous flow.





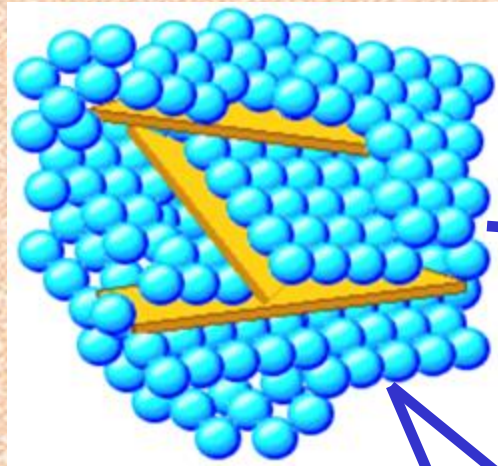
**Liquefaction
and shear
makes
a difference!**



CORE
Dalgara, WA

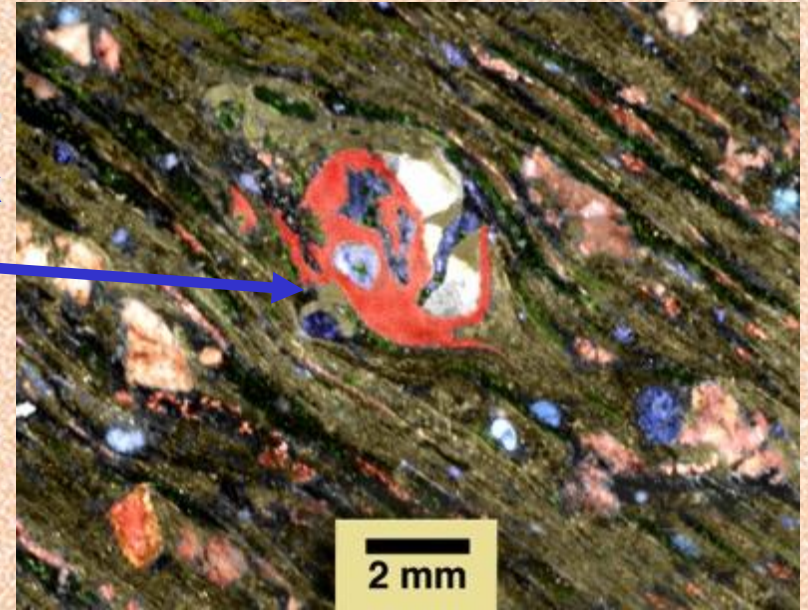
Sediment re-texturing!





CORE

Explorer 7
Tennant Creek

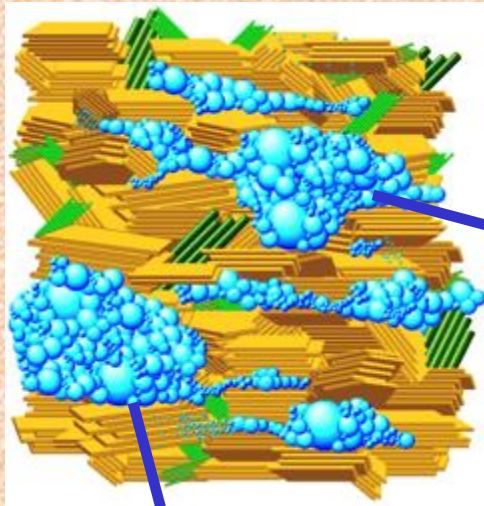


CORE

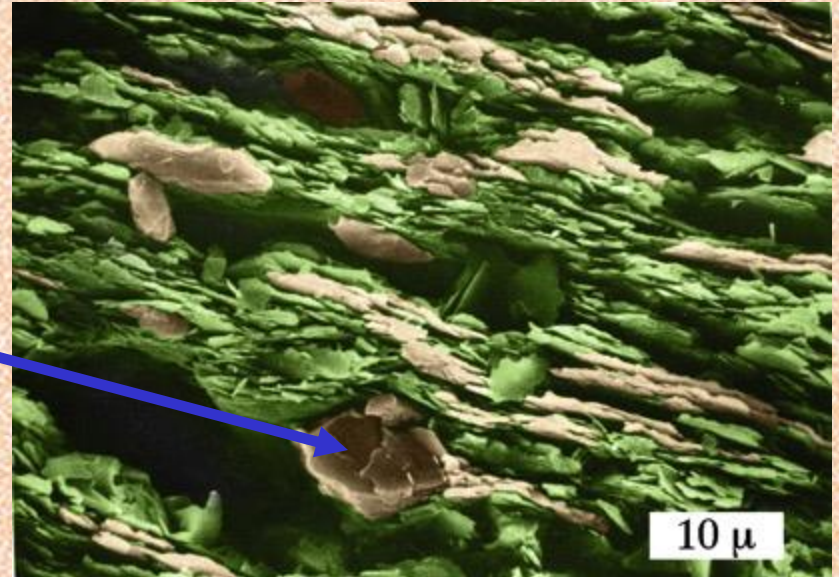
Peak Mine
Cobar NSW
(in pelletoid
mud-flow deposit)

Partly formed impure siliceous accretions





SEM



Chert lenticules

(Weaver, 1985, Fig. 37)

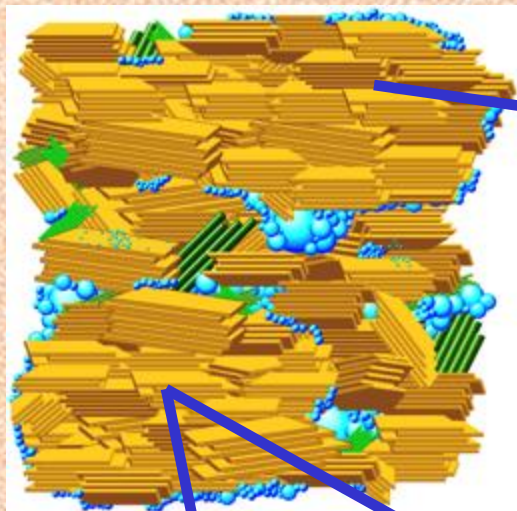
**Quartz
accretions**



CORE
Dalgara, WA

Quartz accretions forming in sheared mud





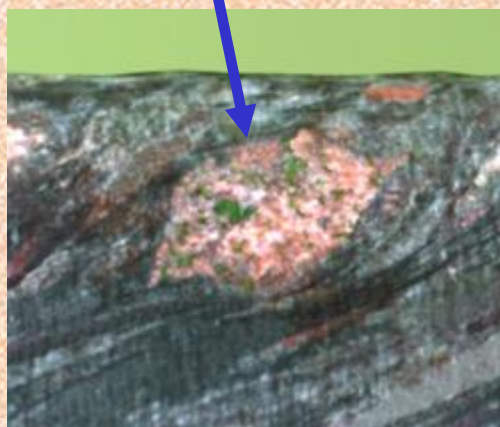
SEM

**Clay accretions
crystallise to
feldspar because
they are ordered**



(Weaver, 1985, Fig. 19)

Chert



CORE

**Explorer 14,
Tennant Creek**

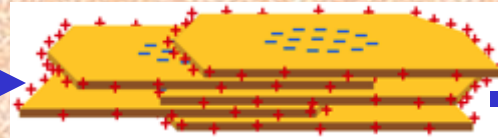
Clay and silica accretions in a mudflow deposit



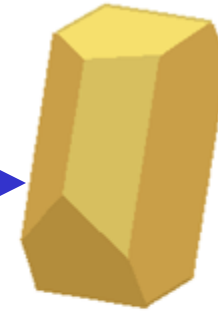
Charged
clay
particles



Close packed
Accretions
(synerectic)

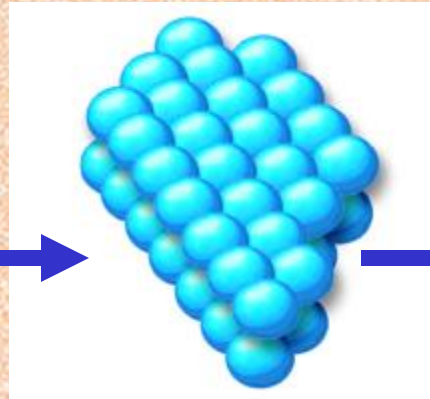
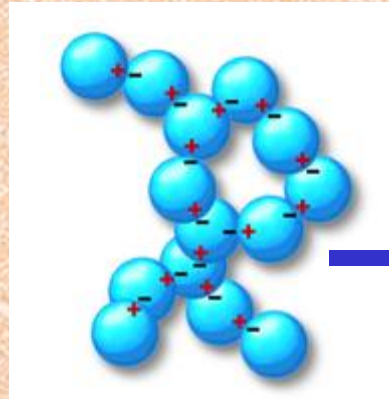


Ordered accretions
crystallise



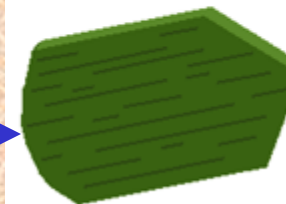
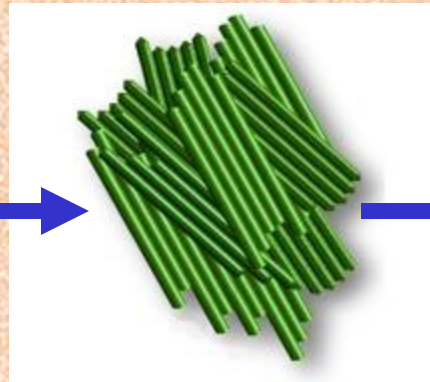
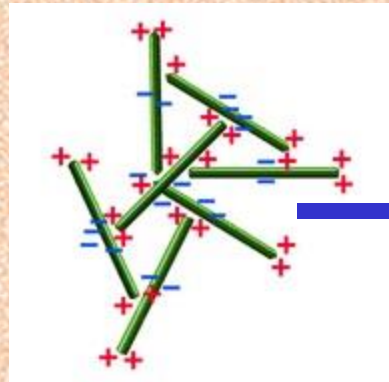
Feldspar

Charged
silica
particles



Quartz

Charged
hydrous
ferro-mag
particles

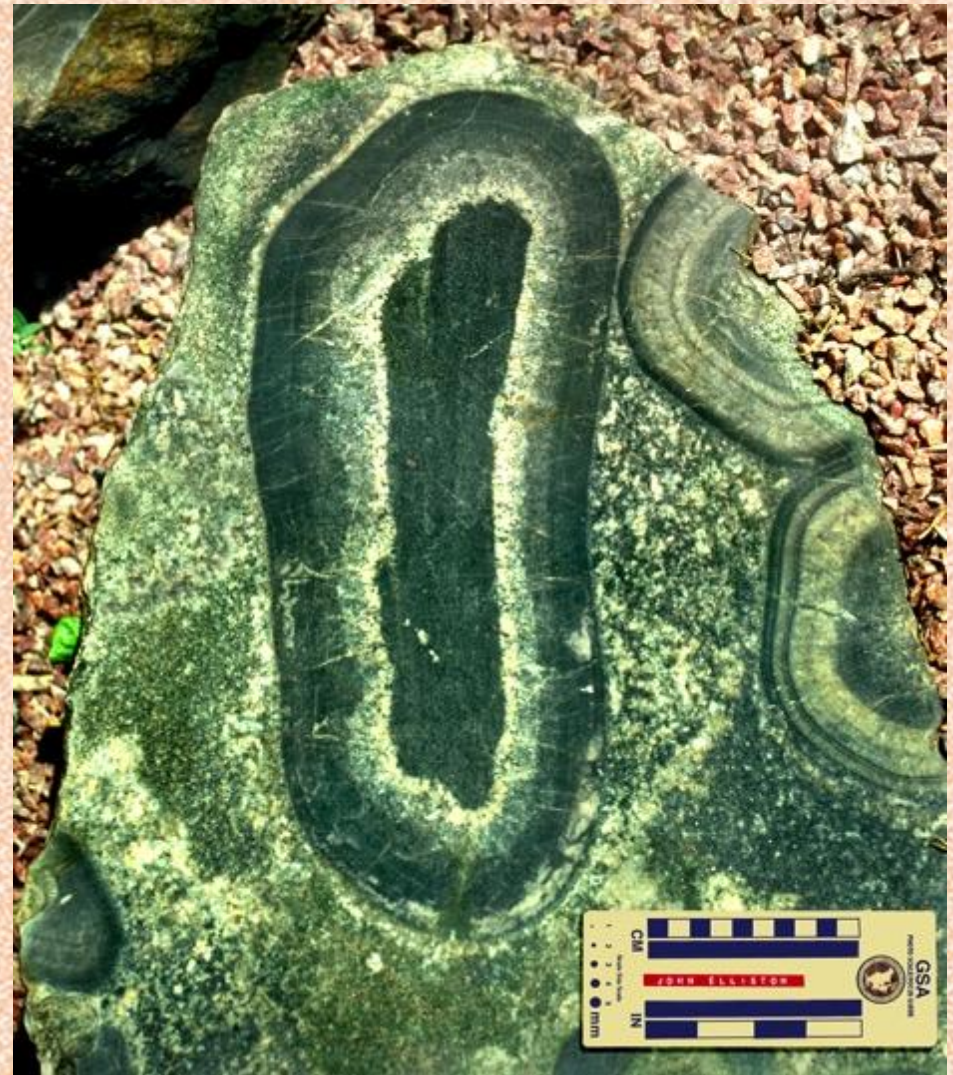
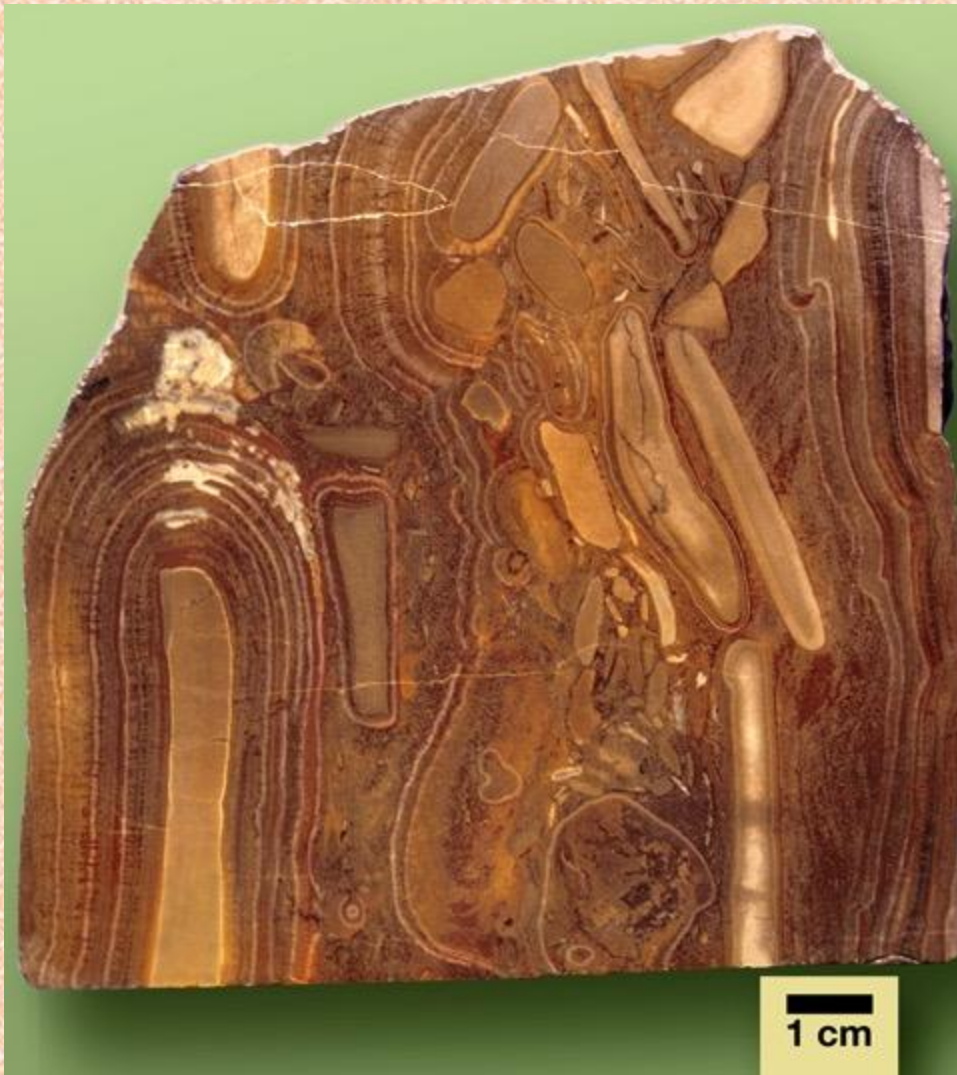


Biotite



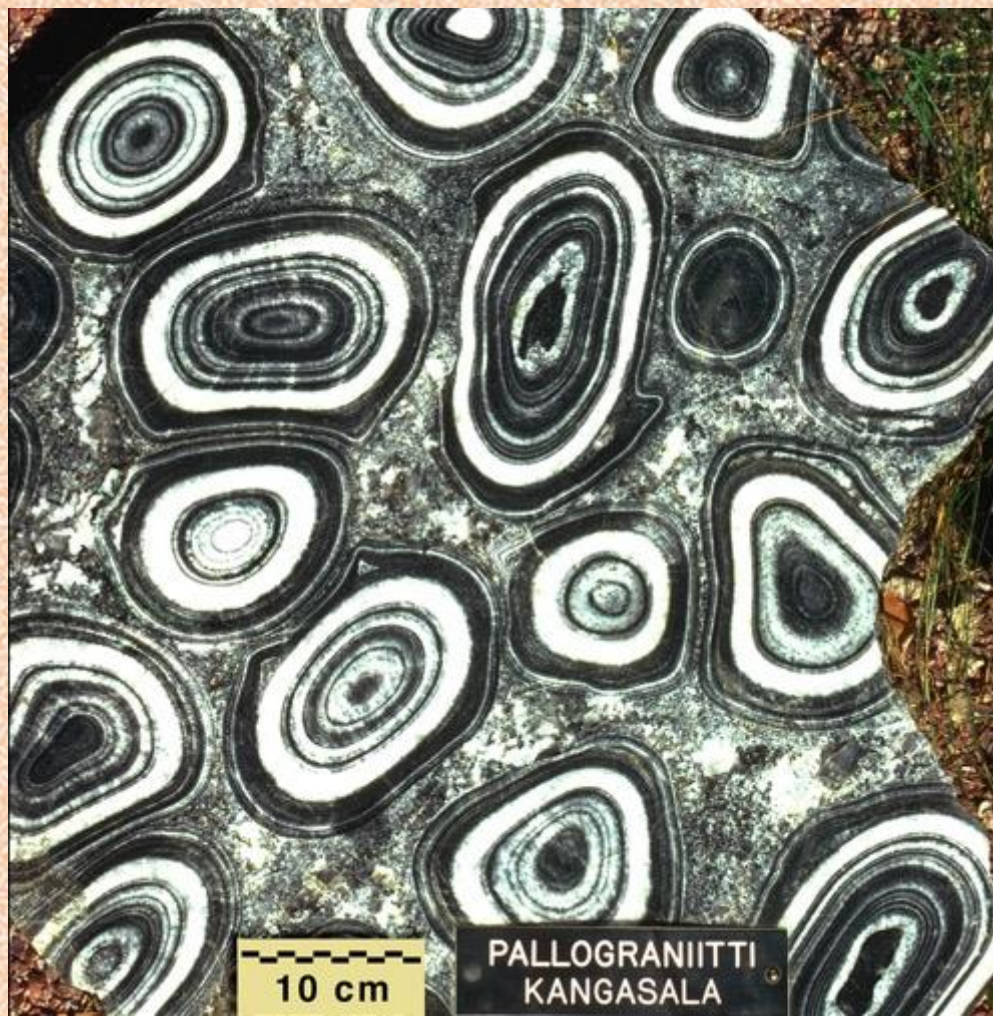


SYNERECTIC DESORPTION exudes very small smectite particles from within illite accretions.



Concretionary structures round fragments in dolomite have the same genesis and characteristics as concretionary structures round fragments in granite.





**Concretionary orbicules in
granite, Kangasala.
Finland.**

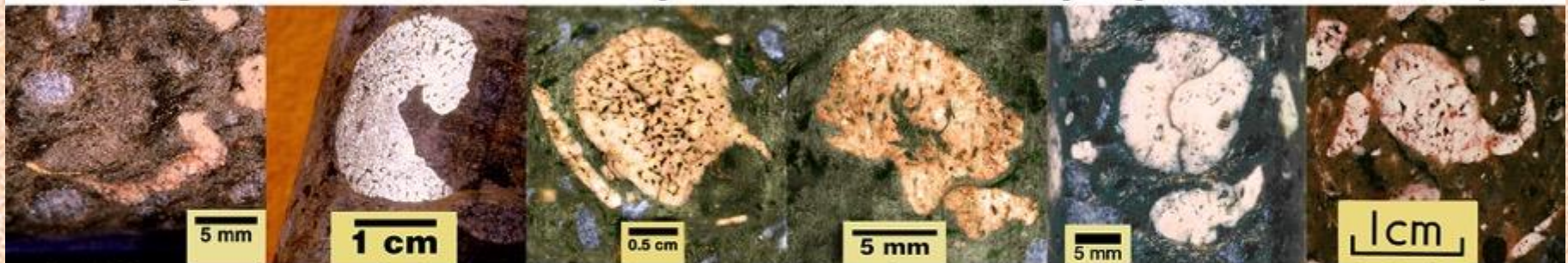


**Jasper concretions from
Jillawarra prospect W.A.**

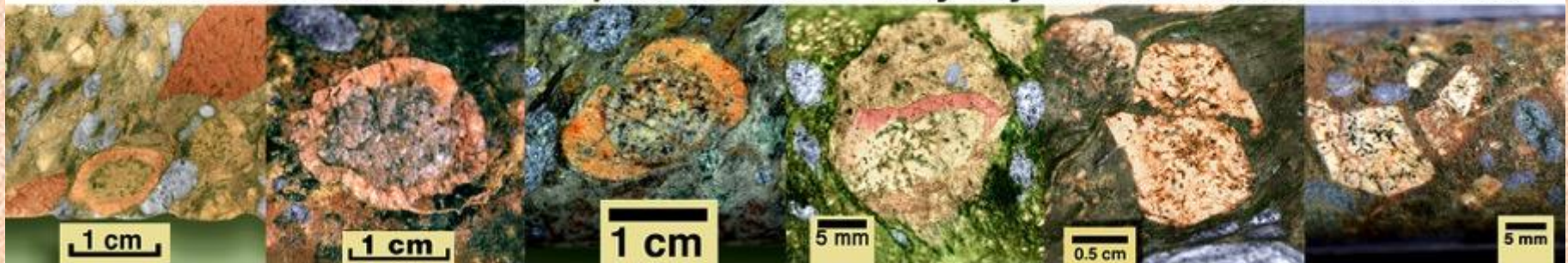




Shrinkage cracks in rounded clay nodules before they crystallised to feldspar



Evidence the nodules were plastic before they crystallised seemed definite



Some Great Western feldspars were rimmed, joined together, broken - clearly they could not have crystallised from a melt or come from a volcano

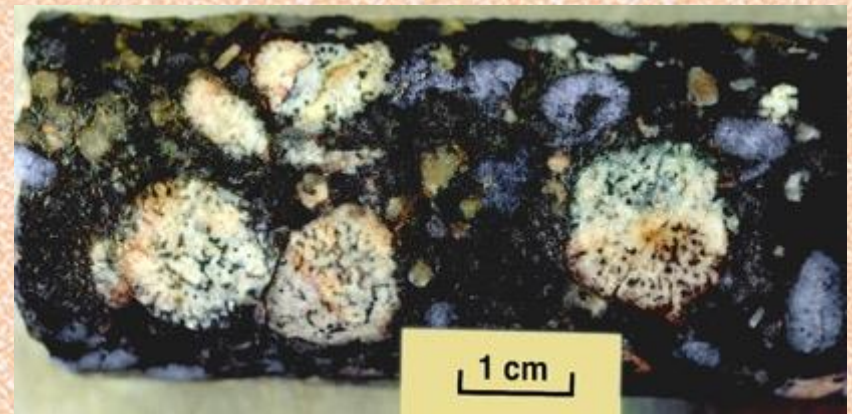
Feldspars in good source rocks look like these!



**Good source
rocks look
like this in
drill core.**

**More detailed
work would
be justified.**

**Synerectic
porphyroid at
Warrego Mine**



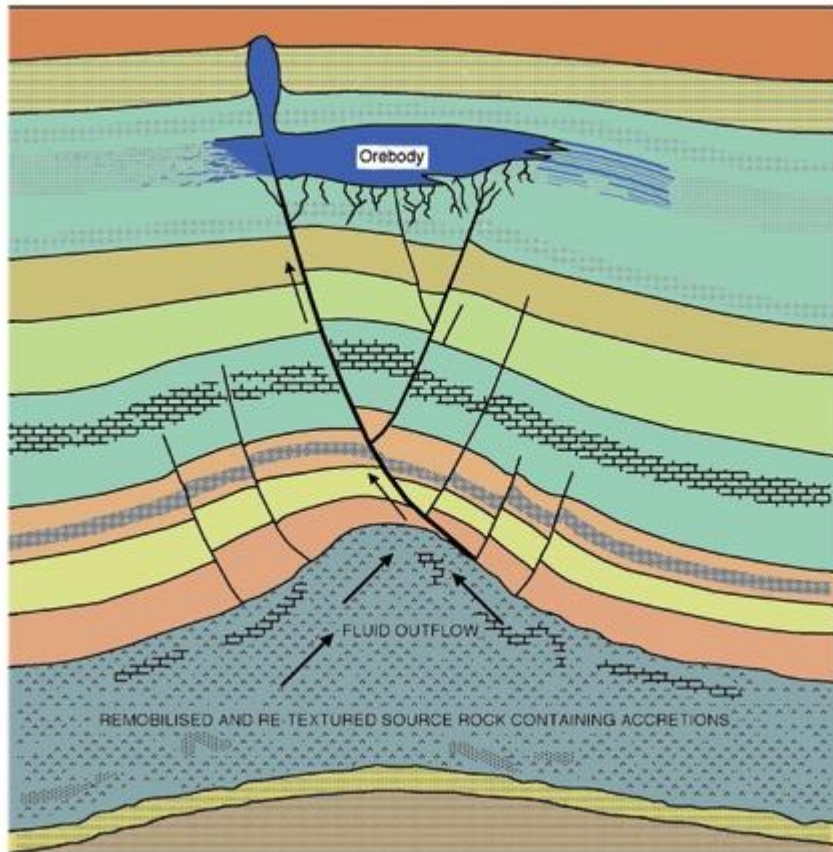
**Synerectic
porphyroid at
Wagga Tank,
NSW**



**Synerectic
porphyroid
from Peko
Mine area**

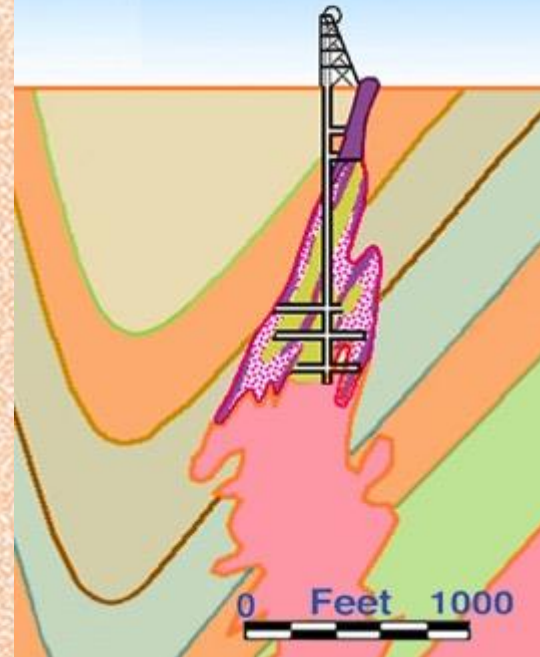


GENERAL DIAGRAM REPRESENTING OREBODY FORMATION IN SEDIMENT LAYERS

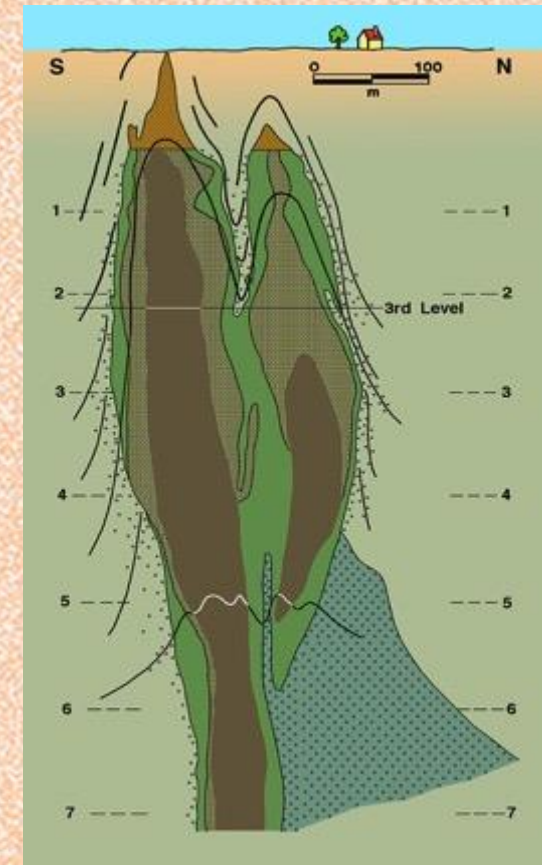


General section of an ore forming environment

Peko Mine, Tennant Creek
intrusive mineralised
ironstone breccia



Peko intrusive
quartz-magnetite

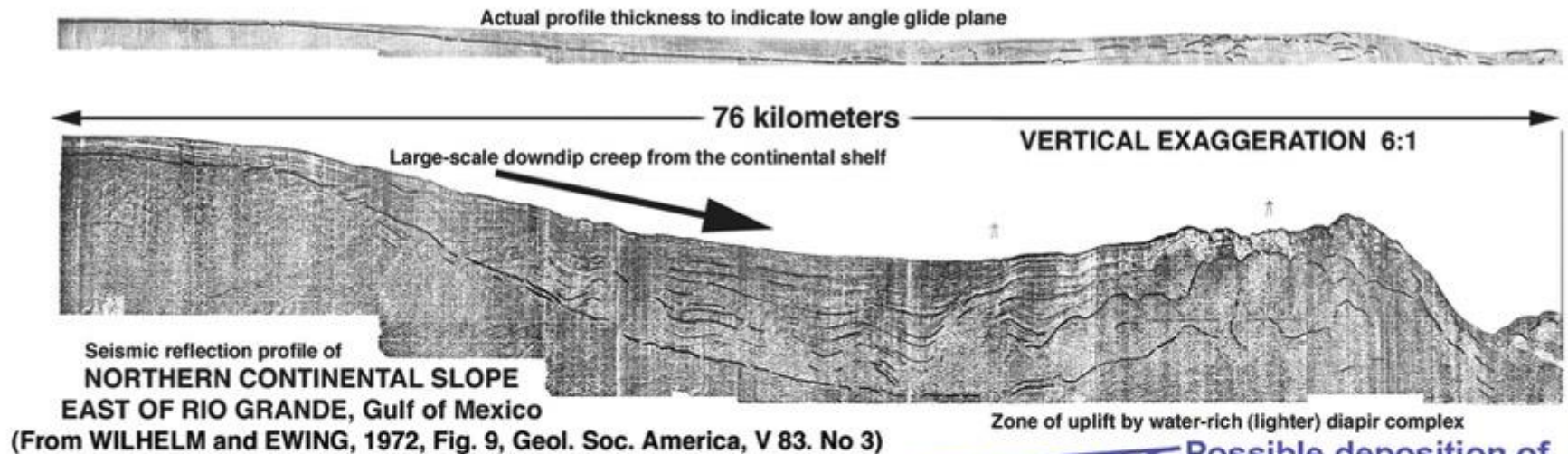


Elura intrusive ore

During diagenesis about three tons of water is released from sediment for every ton of much denser rock that is formed. The fluids have to seep out .



A large mass of buried wet sediments has resulted from progressive down-slope creep of shelf deposits approximately 900 to 1200 m thick.



The thixotropic buried sediments have then risen as a complex of massive episodically liquefied and re-intruding diapirs through the accumulated slump deposits.

Liquefaction and upward intrusion of sediments within a large slump structure provide possible pathway for ore mineral deposition.

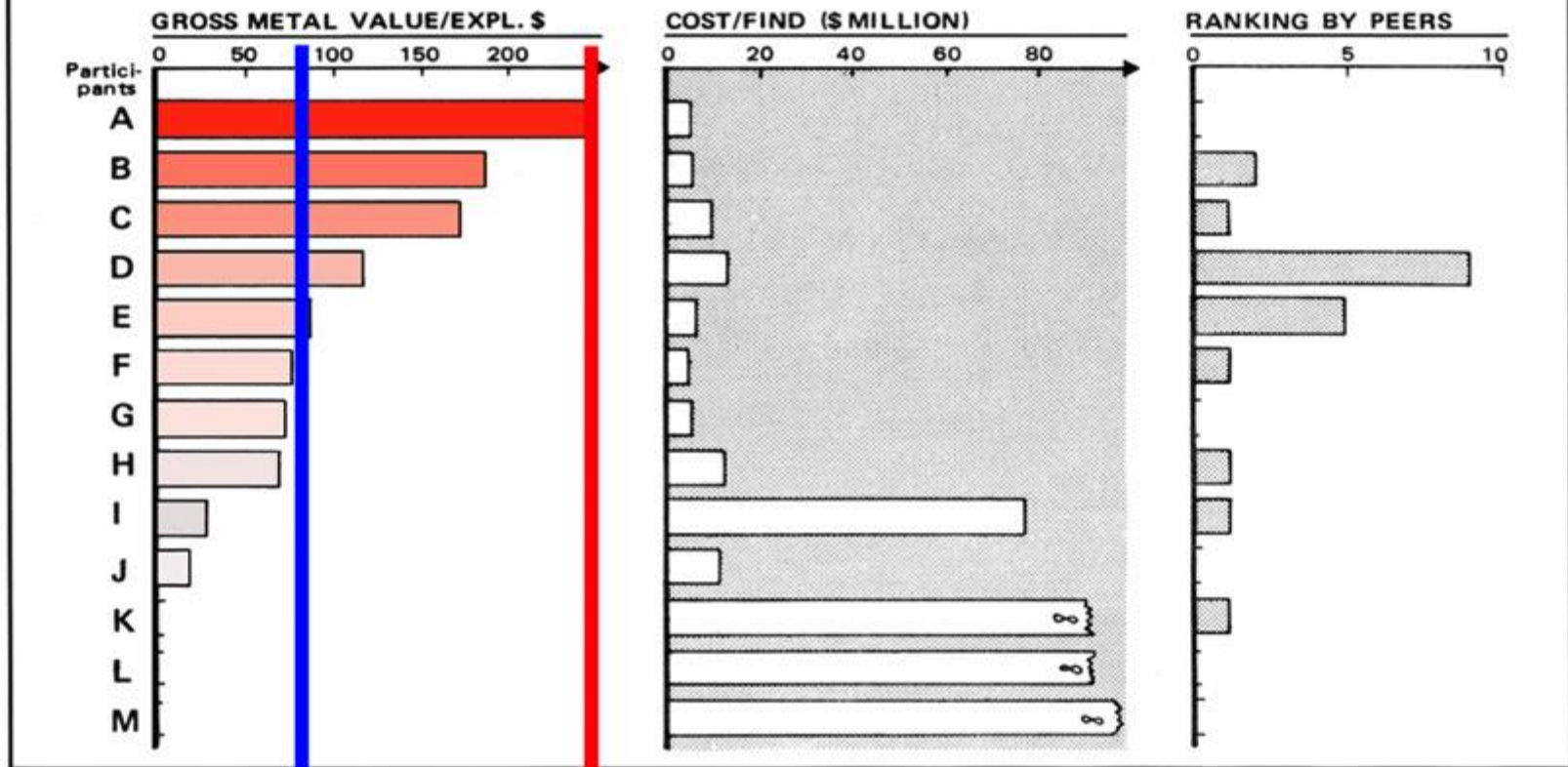


***COST EFFECTIVENESS of systematic mineral exploration
as shown by an independent management consultants
survey of 13 successful Australian exploration companies.***

***PERIOD: 15 years
1960 to May 1975***

EXHIBIT 1

Measures of success



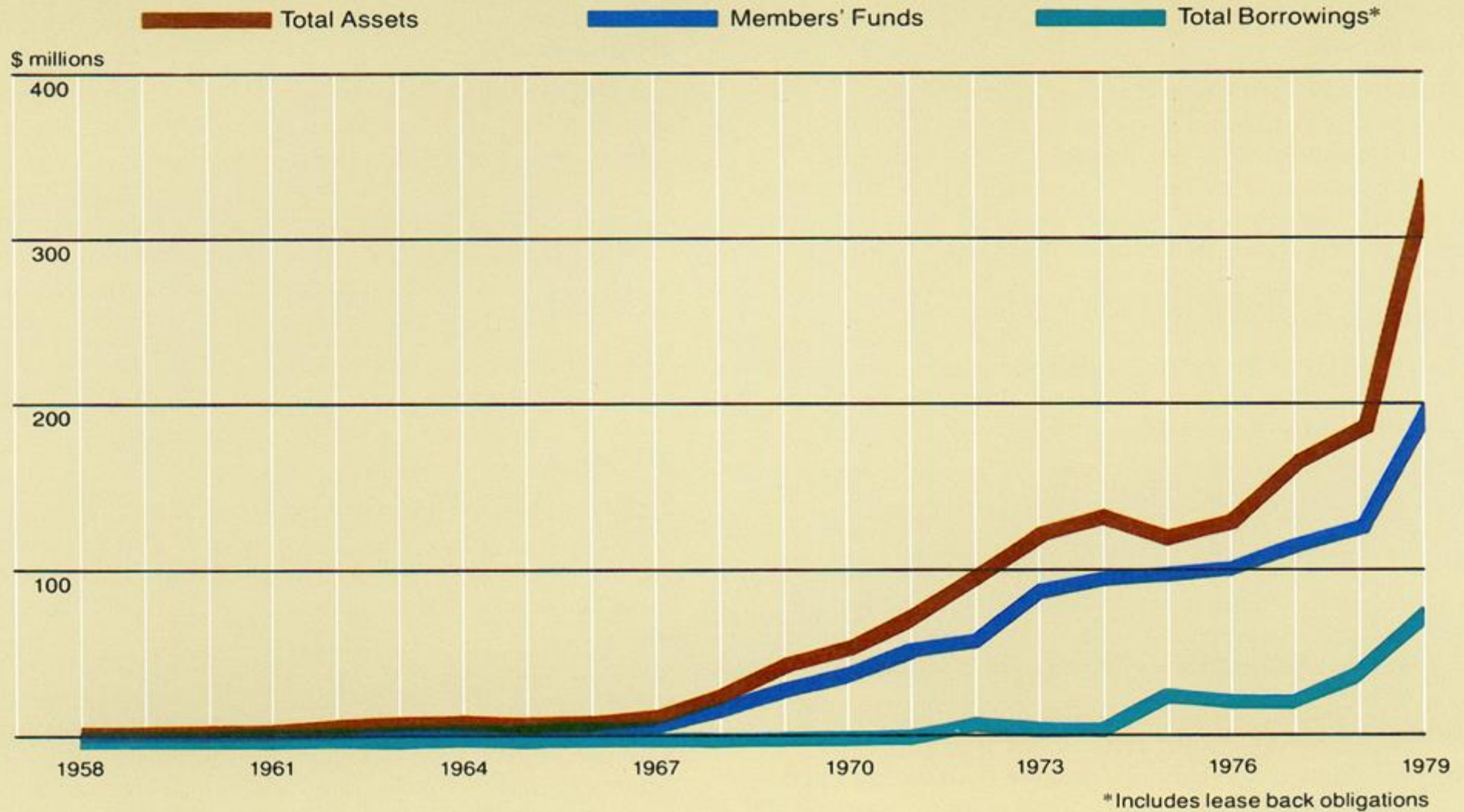
\$82 =

***Average in-ground value of
metal found in 15 years by 13
companies for each exploration
dollar they spent to find it.***

\$275 =

***Geopeko by use of excellent geophysics,
field procedures, and their application
guided by a developing understanding
of source rocks and mineral deposits.***

Growth of Balance Sheet Items 1958-1979



It can put a very nice increase in the bottom line!

