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Native silver may be either primary or secondary. Secondary or supergene native silver is formed by the well known processes of reduction after oxidated products when the water come into the zone of secondary enrichment of reducing environment. In this mode of origin, silver is formed through the agency of meteoric aqueous solution at temperatures near ordinary. In certain types of deposits however, native silver is thought to be formed as a primary mineral. It is again formed by aqueous solution but juvenile i.e. not meteoric solutions the temperature of which may be anything between ordinary and critical temperature. There should not be any essential difference between microstructure of silver deposited by meteoric solutions and that of silver deposited by cold hypogene solutions. When, however, the silver is formed from highly-heated hypogene solutions, the structure of the silver may be expected to be different, for silver recrystallizes when heated above a certain temp. assuming a characteristic microstructure, of which twins of the "annealing-twin" type are a feature"

The lowest temp. at which the recrystallization can occur depends on the extent to which the metal is strained before heated. The temperature at which severely distorted silver begins to recrystallize in a laboratory experiment is just over 200°C. ~~But in geological ages is certain~~ silver would recrystallize at temp. appreciably bellow 200°C. The important factor pertinent factor in these cases is ~~temp~~ time; geological ages. If silver does not recrystallize at the temperatures normally rulling in the oxidation and secondary enrichment zones where supergene silver is normally found, it would be expected that recrystallized structures in native silver would be exceptional rather than common. Yet, of the 21 specimens examined and 35 quoted from Van der Veen paper, only 7 had completely escaped recrystallization. The rarity of non-recrystallized structures in the this commonly supergene metal suggests that Ag can recrystallize at ordinary temp in geological ages. Ag, however ~~slow~~ recrystallizes at ordinary temp when certain favourable factors (severe strain f. instance) are present, and in these cases the alteration of ~~temp~~ structure is localized, imperfect, ~~incomplete~~ and ~~shows~~ as a rule relighian evidence

at somewhat lower temps the process ~~however even with almost no strain~~ (though that natural

become exceedingly slow

low temp.
of the former structure. Where all the silver from a given deposit has a homogeneous recrystallized structure, it may be deduced that the silver has been formed at a high temp, or has subsequently been thermally metamorphosed.

The author's contention is that when the structure indicates, by reason of its homogeneity and coarseness of texture, that the metal has recrystallized under the action of heat, then the temp to which the metal has at some period of it's history been heated is probably not lower than the highest temp. at which it fails to recrystallize in reasonably prolonged laboratory experiments ~~such~~

The author examined 21 ~~specimens~~ specimens from 14 localities by means of the metallographic microscope and by heat-treatment. At the same time he developed a very effective and useful method of polishing Native Ag, so easily distorted and otherwise so hardly handled by ordinary grinding methods

~~The~~ description of some specimens ~~and their~~ structures, and their environment during heating are elucidative

No1 Elkhorn Mine, Montana. Dendritic fragment of native silver, which microstructure consisted of irregular zonal markings (sketch) and herring bone markings (sketch 2) The sharpness of the zonal markings and the complete absence of recrystallization, show that the Ag was formed at a low temperature ~~and its~~ Its structure is clearly the original structure of the metal as it was laid down. It is not an equilibrium structure and would be destroyed by heat. ~~low~~ The specimen was heated by steps of 20°C At 210°C some parts of the silver began to recrystallize. but the recrystallization did not spread throughout the specimen till the temp reached 250°C (sketch). Even at this temp the structure did not become homogeneous (as is shown in sketch) The zonal markings were still clearly visible though they were less sharp and distinct. Only at 350°C (sketch) the structure became homogeneous

The fact that the structure altered visibly at 210°C shows that the Ag had never been at a temp so high as this, therefore formed by an aqueous solution at low temp.

On the other hand ~~way~~ ~~the silver~~ from Lake Superior which is generally thought to be formed by juvenile hot solutions, presents always a coarse, homogeneous, recrystallized structure like that of sketch (micro 8) and that is similar to that produced by annealing silver at a temperature above its recrystallization temp. The silver at Lake Superior is formed as proved by geologic ~~paragenetic~~ evidence ~~is, for reasons paragenesis with~~ and by conclusions drawn from ~~parag~~ the at environment of the silver itself as well as that of the ~~closely associated~~ copper*, formed between 200 and 250°C

In conclusion, the native silver from most localities, has been deposited by meteoric waters, or by cool hypogene solutions, but at Excelsior Prospect (North Rhodesia), at Lake Superior, and in the Cobalt district of Ontario, it has been deposited by hot "juvenile" solutions at temps above 200°C

The author includes in his paper a very interesting study of the constitution of certain natural alloys from Cobalt, Ontario, ~~whose significance escapes the aim of this summary.~~ which has been excluded from this summary because it does not relate to geothermometry.

* The author made a similar investigation on native copper and was able to draw out in the same way ~~some other~~ important conclusions concerning temperature of formation of that metal.

Trans. Inst. M.M Vol XXXIX pp 238-69

A explicação de Yates sobre origem do minério a partir de qz diorito posterior a granito que por sua vez é posterior ao norito é muito mais cabível no caso e explica melhor as relações de certos granitos com o corpo intrusivo norítico e com os offsets. É mais facilmente entendível e no caso é muito mais lógica do que a adotada por Collins (1936) que recorre a uma complicada e discutível argumentação. Isso não quer dizer que a expl. de Yates seja verdadeira e a de Collins falsa. Pode ser mesmo o contrário, desde que Yates não refuta (tanto quanto sei) certos argumentos pesados de Collins.

Aparte ao Rudy

Yates não explica a existência de um pequeno veio de granito Creighton na própria rocha de offset i.é qz-diorito em Copper Cliff (Collins pg 41)

Inconsequencias

Collins T R S C 1936 pg 41

~~The~~ granite (near ~~Cl~~ at Clarabelle Lakes and vicinities) is coarse grained and porphyritic right up to the contact (with the Copper Cliff offset)

Same page

The main niquel irruptive and the (Copper Cliff) offset are both in contact with the same phase of the Creighton granite, the coarse porphyritic phase, ...

Yates St G Can Or Dep pg 60!

The ~~oldest~~ granite in the immediate vicinity is a coarse uniform-grained, pink variety

É claro que ambos falam do mesmo granito, desde que a localização dada é precisa. Como diz Yates "It occurs near and around [s] the Copper Cliff offset in the vicinity of Clarabelle lake.

Copper cliff é extensão do norito (Collins)
" " é desligado do norito (Yates)

Há certa esperança
(mostrar chapa)
explicar o que é e como são offsets
e outros não. Ler razões Collins durante a Petrografia

Collins pg 41

All ~~but~~ ^offsets^ two (Frood e Worthington) connect directly with the main irruptive by broad bases. and In the case ~~of Copper~~ ^the junction^ Cliff offset and main irruptive Collins found "all the evidence to indicate a gradational passage from one to other

Yates pg 60 S G.G.O.D.

"In the case of the two main offsets along the south side of the intrusive - the Worthington and the Copper Cliff - the qz diorite is not found in direct contact with the norite, so that the relationships are impossible to determine directly.

No entanto Collins fez um muito completo estudo ^petrografico e fisico^ da gradação observada na base do Copper Cliff offset. Yates não diz uma palavra sobre isso nos trabalhos que li

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Collins à pg 51 T.R.S.C. 1936 diz que o magma norítico dissolveu considerável porção de Whitewater. Assunto grave esse. Terá mencionado isso em 1934. Fala em assimilação? Ler com atenção

Trans RSC. 1936 pg 29

The life History of the Sudbury Nickel Irruptive

III Environment W.H. COLLINS

O offset de Creighton, ninguem discute, é intrusivo, i.é posterior ao granito. Se o granito é + velho que a irrupt niquelifera então as evidencias indicando que o minerio provem da eruptiva niquelifera (norito) está em harmonia com as relações mostradas por gr. e irrupt e pode ser aceita com confiança. Mas se o granito é mais novo que a irrupt, segue-se que os depositos metaliferos são tão mais novos que a irruptiva que eles não poderiam ser provindo dela.

Passa a discutir os corpos graniticos

1) diques graniticos. Distingue 2 especies ambas encontradas na irruptiva:

a) diques rosados, gran fina, aplitica não porfiritica, compridos as vezes até 10 m de largo. Alguns falhados. Formam verdadeiros diques intrusivos e posteriores à irruptiva. Podem ser encontrados até bem dentro da irruptiva Ex. no contacto norito-micropegm.

b) Apofises aparentando diques encontrados no contacto Norito-Creighton granite. Petrografia inteiras similar ao Creighton granite, i.é, granito porfirico (tipo Pirituba)

2 Granitos

a) Murray - Equigranular rosado gran media uniforme. Contem raras inclusões de greenstone e aplitos mais finos e mais claros. Forma 2 stocks na borda sul da irruptiva. A única evidencia de relação de idade c/o norito reside em diques. não mostra outros sinais de contacto. Expande uma rede de pequenos veios na direção da irruptiva junto ao contacto mas existem muitos outros do tipo 1) a) descritos acima (identicos ao Murray (quimica) e aos pequenos veios de contacto) e que ocorrem bem dentro da irruptiva. Assim, o Murray parece ser mais novo que a irruptiva. Duvida, na mina Murray foi encontrado um dique desses cortado por offset da irruptiva e contendo minerio. Explicação de Collins: talvez se trate de dique ~~de granito~~ provindo de granito que não o Murray (mas qual?). Collins não faz mais menção desse importante detalhe em todo o trabalho. Prefere esquecer.

b) Birch Lake Intrusivo na serie Bruce. Não mostra efeitos de contacto com quaisquer encaixantes. É apenas cortado por um offset da irruptiva em um ponto. Portanto deve ser anterior a irruptiva. É uniforme maciço ~~rosado~~ de fraca a profundamente rosado. Quartzo subordinado. Feldspato compri

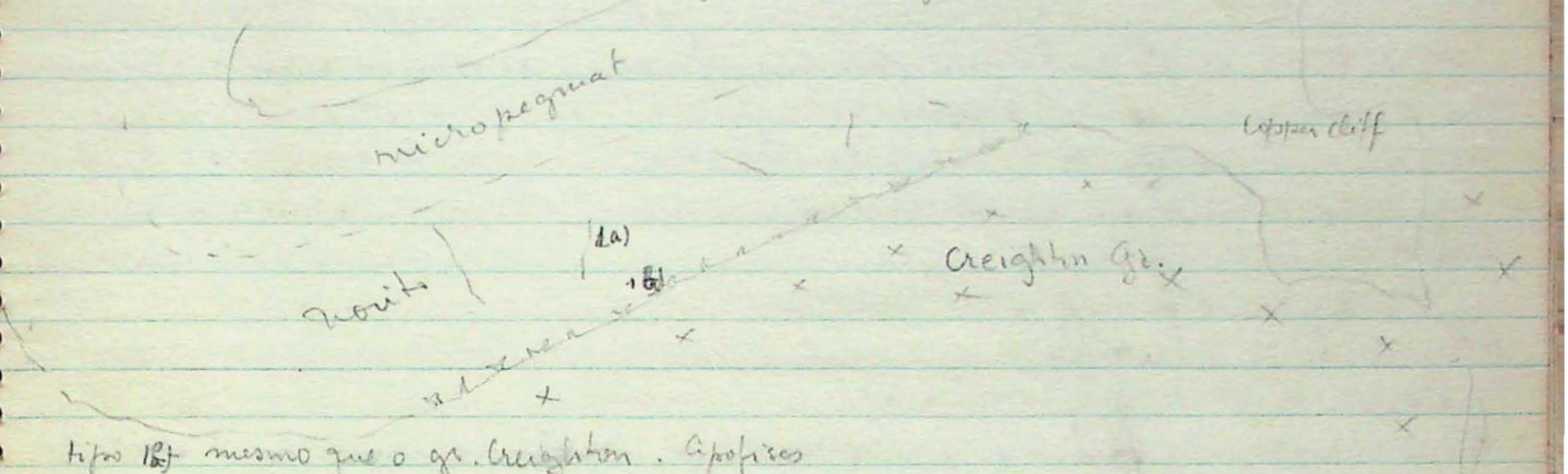
c) Creighton Formado principalmente por 3 variedades

a) A mais comum. Porfirica (tipo Pirituba) Pouco quartzo

b) Equigranular muito quartzo. Restrita Provavel (posterior a a)

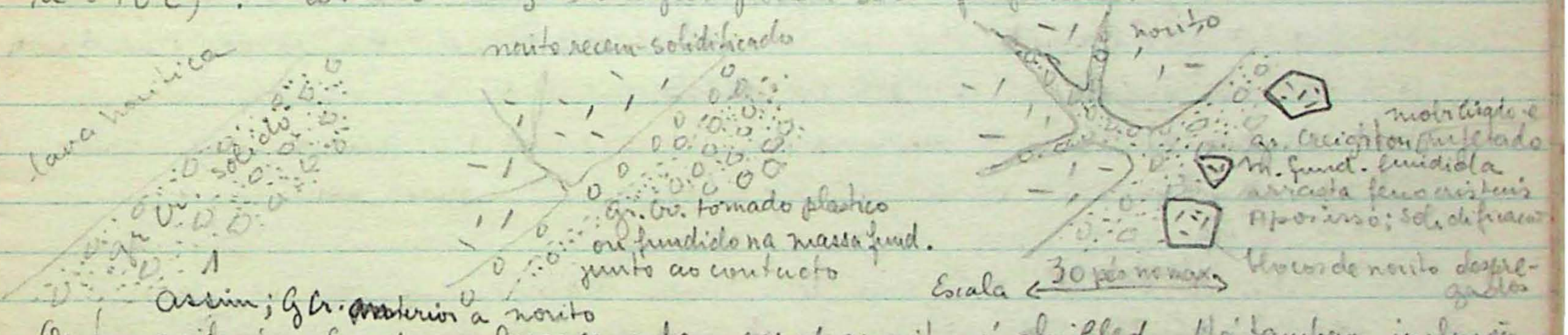
c) Rosada fina aplitica em pequenos dikes. Corta a) e b) Posterior.

Coleman admitiu o granito Creighton deve ser composto do minimo por duas frações respectivas anterior e posterior à irruptiva. Realmente na zona sudoeste do elipse de norito o gr. Creighton parece intrusivo



tipo 1b) mesmo que o gr. Creighton. Apofises
" 1a) aplíticos. Verdadeiros diques

Mas esses diques são de duas especies 1a e 1b) descritos atraz. Collins acredita que 1a) é realmente intrusivo mas (não é relacionado ao granito Creighton, e o 1b) é apenas pseudodique formado por fusão parcial quando o norito posterior se introduziu. O gr. Creighton teria sido mobilisado e injetado dentro de rachas do norito a esse ponto já brecciado. A temperatura a essa altura seria menor que a da cristalização do norito (já estaria solido) e maior que a de fusão do granito (torna-se plastico pelo menos a 570°C). Assim trez estagios podem ser figurados



Assim; Gr. Cr. posterior a norito

Outras evidencias: Em alguns lugares embora raras o norito é chilled. Há tambem inclusões verdadeiras de gr. Cr. no norito. A situação reversa (inclusões de norito no gr.) tem sido descritas mas Collins não acredita que sejam norito mas sim rochas basicas mais antigas e que ocorrem no local. Contradição de Collins; à pg. P339 descreve inclusões de norito à boca dos pseudo-diques

A evidencia mais forte no caso das relações com o gr. Creighton é o da ocorrencia do offset de Copper clif que Collins acredita ser apenas 1 protusão do norito ∴ norito posterior a gr. Cr.

Yates acha que o gr. Cr. é realmente posterior ao norito. O caso de Copper cliff pode ser explicado se se supõe que ele é (como todos outros offsets e algumas bandas no contacto da base do norito) formado por outra rocha muito posterior ao norito e posterior tambem ao granito. Trata-se de qz. diorito talvez genetica e espacialmente relacionado ao norito mas separado em idade.

Collins responde dizendo que 1) Os Offsets se encontram junto ao norito ∴ provavelmente relacionados (Yates não diz que não mas acha que essa localização se prende a fatores tectonicos favoraveis e não ~~à~~ diferenciações de borda)

2) Os offsets se ligam geralmente ao norito por bases largas. Em Copper Cliff essa junção mostra passagem gradativa do ponto de vista petrografico e fisico entre norito e rocha de offset.

3) Lentes de rocha do tipo ~~das dos~~ offset encontra-se ao longo da base da irruptiva formando uma camada basal descontinua (no sentido da extensão só? ou tambem no comprimento transversal) e formando parte integral da irruptiva

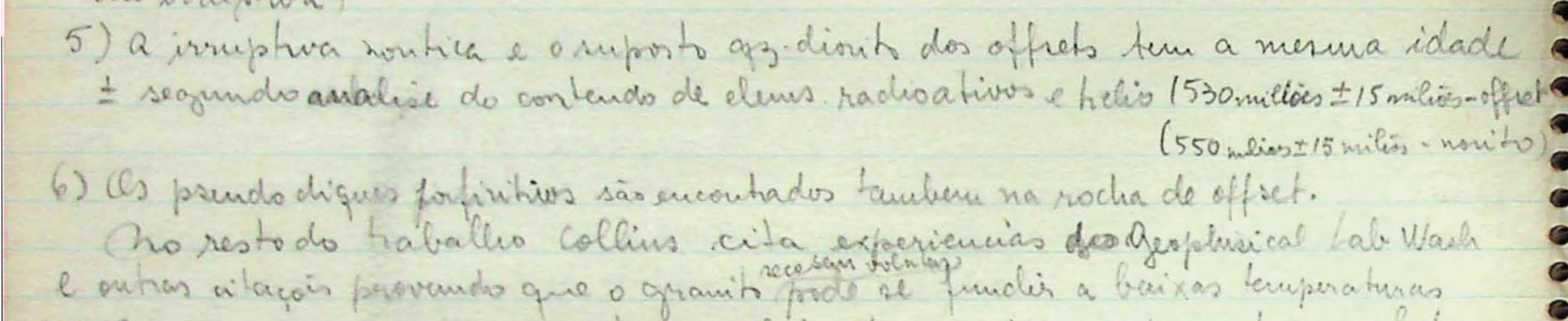
4) A rocha de offset tem ± comp. quim = media calculada para a porção noritica da irruptiva)

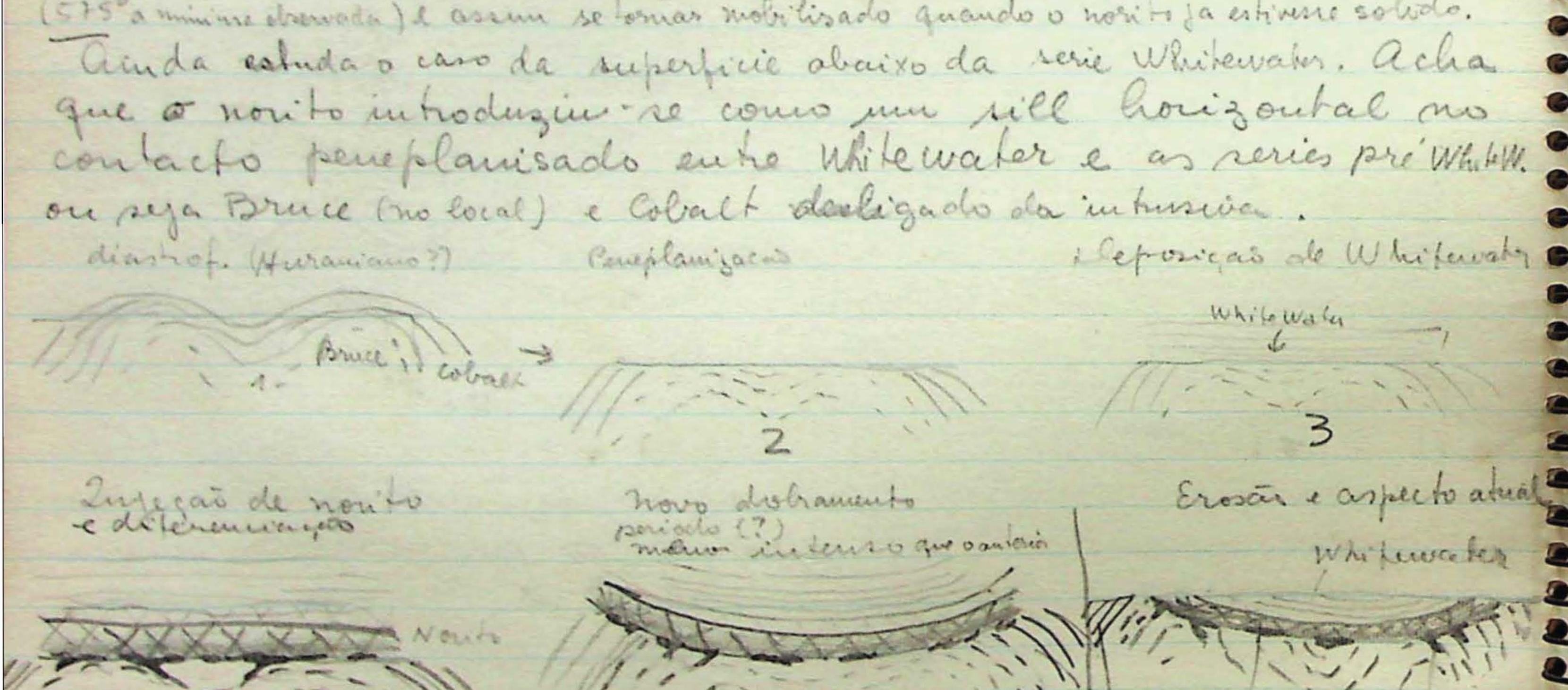
5) A irruptiva noritica e o suposto qz-diorito dos offsets tem a mesma idade ± segundo analise do conteudo de elems. radioativos e helio (530 milhões ± 15 milhões - offset)
(550 milhões ± 15 milhões - norito)

6) Os pseudo diques porfiriticos são encontrados tambem na rocha de offset.

No resto do trabalho Collins cita experiencias do Geophysical Lab Wash e outras citações provando que o granito ~~pode~~ recessam voláteis se fundir a baixas temperaturas (575° a minima observada) e assim se tornar mobilisado quando o norito ja estivesse solido.

Ainda estuda o caso da superficie abaixo da serie Whitewater. Acha que o norito introduziu-se como um sill horizontal no contacto peneplanisado entre Whitewater e as series pré WhitW. ou seja Bruce (no local) e Cobalt desligado da intrusão.

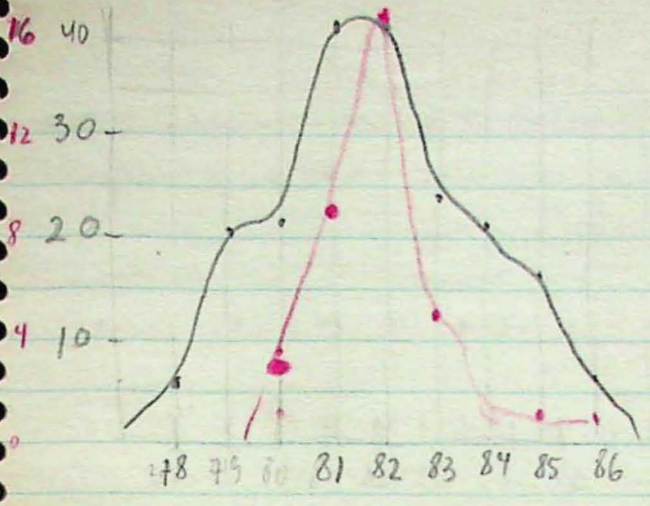




Cobalt   Bruce ~~e~~ e Cobalt
Norito e micropegm

Cooke de modo geral concorda com esses processos admitindo porem existencia de qz diorito posterior a norito (SGGO 20 pg 589) e enormes forças agindo no 2º dobramento provocando a subida de formações sedimentares escondidas por baixo de Whitewater e formando brechas de injeção

Norito 238 (?)
é Quarzo-norito



media de offsets rocks

57.72
58.18
59.76
58.59
23425 ⌊4 58,56 SiO_2

16.60
15.25
15.65
16.21
63.71 ⌊4 15,93 Al_2O_3

2.29
2.26
1.90
2.19
8.64 ⌊4 2,16 Fe_2O_3

7.45
6.62
5.96
5.79
25.82 ⌊4 6,455 FeO

5.81
7.40
5.90
5.48
24.59 ⌊4 6.15 CaO

360
437
405
427
16.29 ⌊4 4,07 MgO

228
247
290
288
2053 ⌊4 2,63 Na_2O

208
189
188
241
826 ⌊4 2,06 K_2O

Micro pegm + norite
2

5532
6783
12315 ⌊2 61,57 SiO_2

13.36
17.62
30.98 ⌊2 15,49 Al_2O_3

182
128
310 ⌊2 1,55 Fe_2O_3

439
549
9,88 ⌊2 4,94 FeO

CaO
204
718
9,22 ⌊2 4,61 CaO

1.50
5.51
7.01 ⌊2 3,5 MgO

382
164
5.46 ⌊2 2,73 K_2O

3,39
2,35
5,74 ⌊2 2.87

	Micropegm	$\frac{\text{Microp+Nor}}{2}$		Offset rock		NORITE
SiO_2	67.83	61.57	3.01	58.56	3.24	55.32
Al_2O_3	13.36	15.49	0.44	15.93	1.69	17.62
Fe_2O_3	1.28	1.55	0.61	2.16	0.34	1.82
FeO	4.39	4.94	1.51	6.455	0.96	5.49
CaO	2.04	4.61	1.54	6.15	1.03	7.18
MgO	1.50	3.5	0.57	4.07	1.44	5.51
K_2O	3.82	2.73	0.67	2.06	0.42	1.64
Na_2O	3.39	2 87	0.24	2.63	0.28	2.35

As to the micropegmatite Yates says that the specific gr. vary from 2.65 to 2.83 and the average is 2.708
An average of 30 selected analyses of this rock is shown on the black board
Mineralogically the rock consists of oligoclase phenocryst and irregular patches of biotite and amfibole in a matrix of quartz and feldspar.

Oligoclase
Biot
Amfibole
Feldspar (K f?)
Quartz.

Of the rocks of the transition zone Yates distinguishes a Pegmatitic phase and a transition zone The description
...sed (at least
1

He begins his paper reporting the achievements of the previous workers in the region. In the next chapter he deals with the geologic relations, petrography and other characteristics of the igneous rocks in the Sudbury basin, that is to say; 1) Norite 2) Micropegmatite 3) Transition zone rocks, including a) Pegmatitic phase rocks b) Transition phase rocks) 4) Offset rocks (Desenhar na pedra)

As to norite, it is said that its specific gravity when measured in fresh specimens does not vary in wide range. Most of the measurements fell in the range between 2.79 and 2.85. The average is 2.8175. The specific gravities plotted against distance from the transition zone show a tendency to rise close to the top of the norite zone, that is, near the transition zone. (mostrar)

Physically, petrographically and chemically the norite is essentially the same from very close to the outer contact to the transition zone.

The average chemical analysis of 25 norites close to 2.82 in sp. gr. is: — — —

and the microscopic calculations on specimens close to that average chemical comp. shows. — — —

As to the micropegmatite, Yates says that the sp. gr vary from 2.65 to 2.83 and the average is 2.708

An average of 30 selected analyses of this rock is shown on the blackboard.

Mineralogically the rock consists of oligoclase phenocrysts and irregular patches of biotite and amphibole in a matrix of quartz and feldspar
Oligocl. Biot - Anfib - Feldspar - Quartz.

Of the rocks of the transition zone Yates distinguishes a Pegmatitic phase and a Transition phrase. The distinction and description he gives is somewhat confused and not well understandable (at least for me!)

In short he establishes the existence of a discontinuous belt of pegmatitic material just bellow the transition zone, presenting the same original mineral composition as the norite. The rock is said to be largely altered with uralitized pyroxenes and saussuritized feldspars.

The rock shows the highest density of all the rocks examined in every traverse

The true transition zone is represented by rocks of changing character, the changes taking place over a relatively short distance from the pegmatitic zone to the micropegmatite. The petrographic description, I found one once again very confused. Yates says that there occur in this belt, aplitic dikes; hybrid rocks and a general granitization. But he says that some true relations between norite and micropegmatite can be seen. The norite becomes coarser and coarser as the transition zone is approached. Than it turns lighter in colour due to change in feldspar which becomes clear and white. Soon this feldspar begins to turn pink in colour and increases in amount while the amount of femics begin to diminish

Of the rocks of the dikes occurring in the adjacent rocks near the outer edge of the norite, Yates transcribes several analysis from which I've calculated an approximate average. The range of percentages of the minerals

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This rock shows the highest densities of all rocks examined in every section ~~thro~~ the basin shows a marked resemblance to the norite of the main irruptive, from which it differs in having a somewhat more acidic plagioclase more biotite, anfibol and quartz. ~~But the~~ The texture is said to be different from the norite but ~~it~~ is not described ~~on~~ this paper. However the presence of both hypersthene and diallage strongly suggests the close parentage to the norite magma.

In the ~~next~~ chapter Yates deals with the relations of the offset rocks to the norite.

The Copper Cliff offset is said by Yates to be composed of a large funnel-shaped mass of norite together with a long narrow dike of qz-diorite extending south from it. Yates states that ~~the~~ it is proved by drilling that no connection exists between the two.

In the Foy offset Yates describes a knife-edged contact, with no sign of gradation between quartz diorite ~~of~~ the dike and norite of the main sheet.

At Murray mine he describes a clear relation in space and time between the two rocks. A tipical quartz diorite throws tongues into the norite and ~~include~~ contains inclusions of norite. So the qz-diorite has to be considered later than norite.

— In the next chapter Yates discuss the relations between quartz diorite ~~and~~ norite ~~complex~~ and granites. He states that the Creighton granite is definitely later than norite because it throws dikes into the norite. There are some contradictory fenomena (the existence for instance) of fragments of granite enclosed in noritic matrix at the end of the funnel-shaped noritic apophisis. Yates however affirms that this is an example of crush breccia formed by mixing indiscriminately granite and norite.

On the other hand the qz-diorite dikes clearly cut~~s~~ the Creighton granite and is then proved to be younger. So the time relation in the Copper Cliff region is norite - granite - qz-diorite

The same conclusions are to be drawn regarding the relations to the Murray granite.
The objection of Collins who described a dike of probable Murray granite cutting the Copper Cliff offset qz-diorite is denied by Yates by saying that such dike in his careful search has never been found.
So the granite is younger than the norite. The quartz diorite must likewise be later than the norite by a period sufficient to permit of the injection and consolidation of the Murray and Creighton granites.
Yates includes in his paper a chapter on the crush breccias occurring in Sudbury ; thought by some authors to be an unusual kind of intrusion behaving like igneous intrusion. There is a high diversity of rock fragments and composition of matrix showing one relation to the wall rocks. Yates in this paper does not conclude anything as to the origin of this rock but says that the field relations are quite clear. It interrupts and includes fragments of both Murray and Creighton granite. It probably cuts and displaces the Copper Cliff offset. It most certainly brecciates the qz-diorite of the Frood offset and cuts one set of trap dikes. It is however cut by the large olivine diabase dikes.
In the last chapter he shortly describes the field relations of the trap dikes thought to belong to different ages and the olivine diabase dikes which is definitely later than the breccia but is cut by some later faulting. The complete sequence of events is presented
1)

From the reading of this paper by Yates I got the impression that Yates is better field geologist or economic geologist than a researcher.

His interpretations based on field relation in this paper are quite convincing and his latter paper published recently in Jubilee Volume is perfectly clear.

However, from the petrographic point of view his first paper may be criticized. There are troughout the paper a number of contradictions and I would say, coarse mistakes which could be subjected to severe criticism.

For instance, at pg 157, he says that the feldspar of the intergrowth in granophyre is micropegmatite (repetir) as far as I know there is not such feldspar

On the same page he states; "The pegmatitic phase, which grades into normal norite, is a very coarse rock with large hypersthene and augite crystals in a gray feldspar-quartz matrix. In some places there is very little feldspar or quartz and the rock is practically an amphibolite." This was the first time I heard that a rock composed mainly of hypersthene and augite is an amphibolite

- Describing the micropegmatite zone he says ~~that~~ "The specific gravities vary considerably because of shearing, alteration and recrystallization" However ~~on~~ the very next paragraph he seems to agree with Collins for he says "As seen on the curves prepared and presented by Collins the specific gravity is remarkably uniform".

- He says that the pegmatitic zone range from few feet to several hundred feet." However he transcribes a curve of specific gravities and describes a tipical pegmatitic zone ~~out~~ at least

At pg 160 he gives percentages of the component minerals of offset rocks. He does not describe K-feldspar but if we look at the table of chemical analysis we see that the K_2O content is near 2 %. The only potassic mineral mentioned is biotite and its amount in the rock by no means explain that ~~divergence~~ percentage.

Almost every time he speaks of feldspar we can not be sure of what kind of feldspar he is telling about. For instance, describing the transition from norite to micropegmatite, he says: "Eventually the rock becomes comparatively coarse but not distinctly pegmatitic. Suddenly it begins to turn lighter in colour, the feldspar becomes clear and white. There is no increase in the amount of feldspar; in fact, it is less abundant, but the change in its colour, together with a tendency to lose its typical lathlike habit, gives the rock a wholly different appearance. The feldspar soon begins to turn pink in colour and increase in amount, until the rock becomes micropegmatite. It seems to me that the special kind of feldspar of the norite, that is, the labradorite does not show a gradual change of colour trough the transition zone but ~~a~~ rather, a decrease in amounts occurring with simpathetic increase of amount of K-feldsp (which he does not mention). We know that K-feldspar is ~~usually~~ very commonly pink and this would explain the change of colour of the rock.

(May be I didnt completely understand ~~his english~~ sentences because I am not very well acquainted with the language and perhaps this would have led me to misinterpretations.)

The pegmatitic material is said to present the highest specific gravity of the whole range of intrusive rocks. Yates does not give any meaning to this important phenomena but seems to correlate it, in some way, to the grain size of the rock. However, the grain size cannot disturb the specific gravity if the mineral proportions remains constant. The explanation to this phenomenon I found in ~~the~~ his description itself. The rock in this zone is almost completely altered to a kind of rock that ~~many~~ authors call saussurite-gabro. ~~By~~ This secondary product brought about mainly by hydrothermal processes ~~increases~~ shows a rare feature, that is, an increased density in contrast to the lower sp. gr. of the original rock. It seems to me that Yates did not recognise this process.

Speaking of Creighton granite, Yates states ~~as~~ (pg 165) that it is a coarse porphiritic white granite containing numerous large crystals of white feldspar. in contrast to what he says on his later paper (S. G.C.O.D. pg 601) when he describes this same granite as a coarse, uniform grained pink variety.

However, Coleman and Collins describe this rock as a coarse grained porphiritic granite whith pink phenocrists.

In his latest work, ~~an~~ Yates interprets ~~by~~ this manner the evolution of the noritic formation. (pg 601)

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However what Yates calls "deuteric alteration" is really a true magmatic differentiation phenomenon, in my view. The micropegmatite texture occurring as grains making up to 50 to 60% of the granophyre could not be explained in other manners. In ~~some~~ many other proved differentiated sills ~~it oc~~ the micropegmatitic material occur as interstitial grains filling the spaces left by the pre-cristallized minerals. Of coarse, the micropegmatitic probably eutectic material is the last to crystallize in the mesh of the rock, and may sometimes attack or corrode or change previous minerals in some way the feature of the rock. But this does not imply that the micropegmatite is not trully magmatic. Should the micropegmatite be considered deuteric product or not, it is anyway formed ~~[illegible]~~ by magmatic process, for deuteric phenomena is included among the processes occurring before the complete crystallization of a magma, according to original definition by Sederholm.

* Yates' statement that there is no good evidence of intense folding ~~or~~ movement after the emplacement of norite is completely divergent from the evidences collected by Cooke who found that the south boundary of the irruptive does not dip gently inward but is steeply inclined and in many

places dips south.

On the other hand, The geologic relations of norite, quartz diorite and granites as explained by Yates completely agrees with the hypothesis of hydrothermal derivation of sulphides. His work published in ~~Trans Roy Soc Can~~ Jubilee Volume is very clear, I would say brilliant and in some aspects much more believable than Collins explanation based on othomagmatic hypothesis.

* ~~moreover~~ The presence of a pegmatitic belt near the transition zone reckoned by Yates himself, strongly emphasises the similarity between Sudbury and Palisade Sill for instance, where this rock is thought by good reasons to be formed by differentiation in place.

105
5-1-53

[signature]

Colors
"Chemico-compositional" colors
"structural" colors

(due to ≠s in reflection or absortion colors
due to inclusions etc but not structural
in the sharpest sense

Idiochromatic color due to essential constituents.
Allochromatic c. " " not "
The first distinction (ch-c.c. & St. c) is the more fundamental.
In ch.c.c. a cor é dada por luz transmitida e é devida à absorção. Pode ser estudada espectroscopicamente. Absortion curves corresponds to a particular color. Pode haver absorção infra red ou ultra-violet (luminescencia se houver retransmissão) mas trataremos só das absorções dentro do range de luz visível que produzem as cores naturais. Da quantidade de luz absorvida depende a cor do mineral.
Deformações em esforsos do material aumenta absorção causando cores mais acentuadas (não confundir c/ pleocroismo) Provavel/ é o que acontece nos oxidos de Fe (hematita magnetita). A reflexão é muito menos seletiva que a absorção mas é eficaz até certo ponto.
Quando um mineral é moído as reflexões aumentam c/ o aumento de superficie e a tendencia é sempre de refletir cores + palidas

---

As cols. c.c de opacos são ~~definidas~~ chamadas reflection or surface colors.
Alguns opacos muito finos mostram a absorção (que sempre existe até certo ponto? que causa a cor na reflexão?) Ouro visto por transparencia em chapas muito finas é verde escuro.

Ao contrario dos translucidos o pó dos opacos tende a ser + escuro que a cor do mineral

Os opacos ou são metalicos ou tem em > ou < extensão propriedades metalicas (condutividade etc)   Trataremos dos translucidos

muitas XX das cores nos translucidos devido a certos constituintes quimicos. Quando estes 5 essenciais temos cores idiocromaticas

Os minerais com ferro ferrico tem suas cores muito mais carregadas que os c/ ferrosos ~~em vermelho geral~~.

Fe''   Fe'''

white or pale   yellow, red or brown.

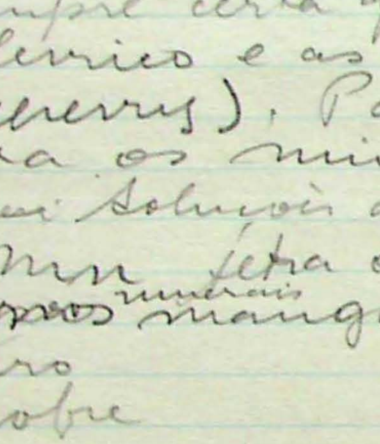
Há outras cores; vivianita azul. $Fe_3(PO_4)_2 \cdot 8H_2O$
Sempre certa quantidade de ferroso está oxidado a ferrico e as cores seriam devidas aos 2. (Weeries). Parece que esse é caso geral para os minerais com Fe''' e Fe'' (a cor azul)
~~Exper~~ Soluções de laboratorio c/ fe''' e fe''' são azuis.

Mn fetra ou talvez tri é o que dá cor roxa e ~~pros~~ minerais manganifero e preta nos que tem ferro

Cobre

Cr nos cromatos é bicromatos (coloridos) é 6

$K_2(CrO_4)$ – amarelo.
$K_2(Cr_2O_7)$ – verm.



105
7-1-52

low	126°	high
tetragonal	HgI_2	orthorh
4 coor		6-coordination
I I Hg I I		I I I Hg I I I
yellow		red

NiF_2 (estrutura de rutilio) — $NiCl_2$ — $NiBr_2$ — NiI_2 (estrutura como $CdCl_2$)

branco — amarelo — pardo — preto

a mudança é estrutural sem duvida.

· Covellite CuS — Indigo blue or darker
Germanite $CuS(Fe, Ge)S$ — dark reddish gray
Rickardite $Cu_2Te\,CuTe\,(Cu_{4-x}Te_2)$ — purple-red
Umangite $Cu_2Se\,CuSe$ — dark cherry red with violet tint
Digenite Cu_9S_5 — blue to black

Todos esses minerais contem Cu^{++}. Alguns tem comp variavel (rickardita) Digenite tambem show deficiency no copper (o ideal seria $Cu_{10}S_5$)

Outros minerais como tetraedrita tem defect structure mas não tem essas cores

Provavel/ os defeitos são causados por diferenças em valencias e as cores seriam relacionadas ao fato.

Rutilio pode ser preto ou vermelho. No entanto TiO_2 branco é usado em pinturas.
Uma pequena deficiencia em Oxigenio pode provocar embranquecimento. Isso pode ser causado por aquecimento
Provavel^{t} as cores em perovskita ($CaTiO_3$) podem ser explicadas da mesma maneira

WO_3 yellow
WO_2 blue — passa a azul quando se tira O.

ex:
$Na_{1-x}WO_3$ azul — Na_2WO_4 colorless

---

as xx coloração pode ser devida a trocas iônicas isomorfas e poder-se-ia talvez em certos casos calcular ~~por~~ % de end member pela cor.
Sabe-se que em soluções isso é possivel
$\log D = x_1 \log D_1 + x_2 \log D_2 \ldots\ldots + x_n \log D_n$

D = vala da absorção de cor.
Se só uma coisa esta absorvendo
$\log D = x \log D$.
Ex
Epsomita ($MgSO_4 7H_2O$) incolor
$NiSO_4 7H_2O$ verde pode empalidecer por isomorph c/ troca de Ni/Mg
(Morenosite)
Sabendo-se a % nos membros puros e se medirmos a absorção teremos facil^{t} o valor de x que dá %
A ≠ entre alocromatica e idiocromatica color torna-se sem mto valor porque Ni p. ex é essencial em morenosita mas em ligeiras verde epsomita ele deve ser tomado como impureza
Porque? Ca em oligoclasio não é essencial?
Pedras preciosas

2/4

Knopf & Ingerson GSA memoir
Knopf (wife) resumo de Sanders Work 1937
Fairbairn many misprints

Deformation in Met rx

The regional met. is the descriptive term covering metamorfism in large scale not obviously related to such local causes as igneous int. The ~~characte~~ classic regions are folded mountain regions ∴ large scale deformations. There is almost universal evidences in small scale on the ocurrence of deformed pebbles & fossils, rotated porphyroblast, corrugation of original plane structs. presence of xistosity sometimes demonstrable due to shear, presence of lineation & microscopic granulation or strain of individual grains. All these points to effectiveness of deformation afecting the smallest units of the rx. There are other obviously defomed rxx myolonits and some xists assotiated with local zones of movement.

The history of a rock is recorded in its fabric rather than mineralogy. Fabric or Gefuge is a very broad term including all textural or structural characteristics. It embraces the mutual relations in space of such fabric elements as ~~fold~~ major fold limbs and axis bending, xistosity, joints, lineation, grain aggregates, grains and part of grains (where the grains are not homogeneous)

The aim of St. Pet. is to present a sinthesis of all fabric data ~~for~~ a given field and if possible to interpret the data dynamically in terms of some stress system or kinematically in terms of movement picture plans (Bewegungsbild)

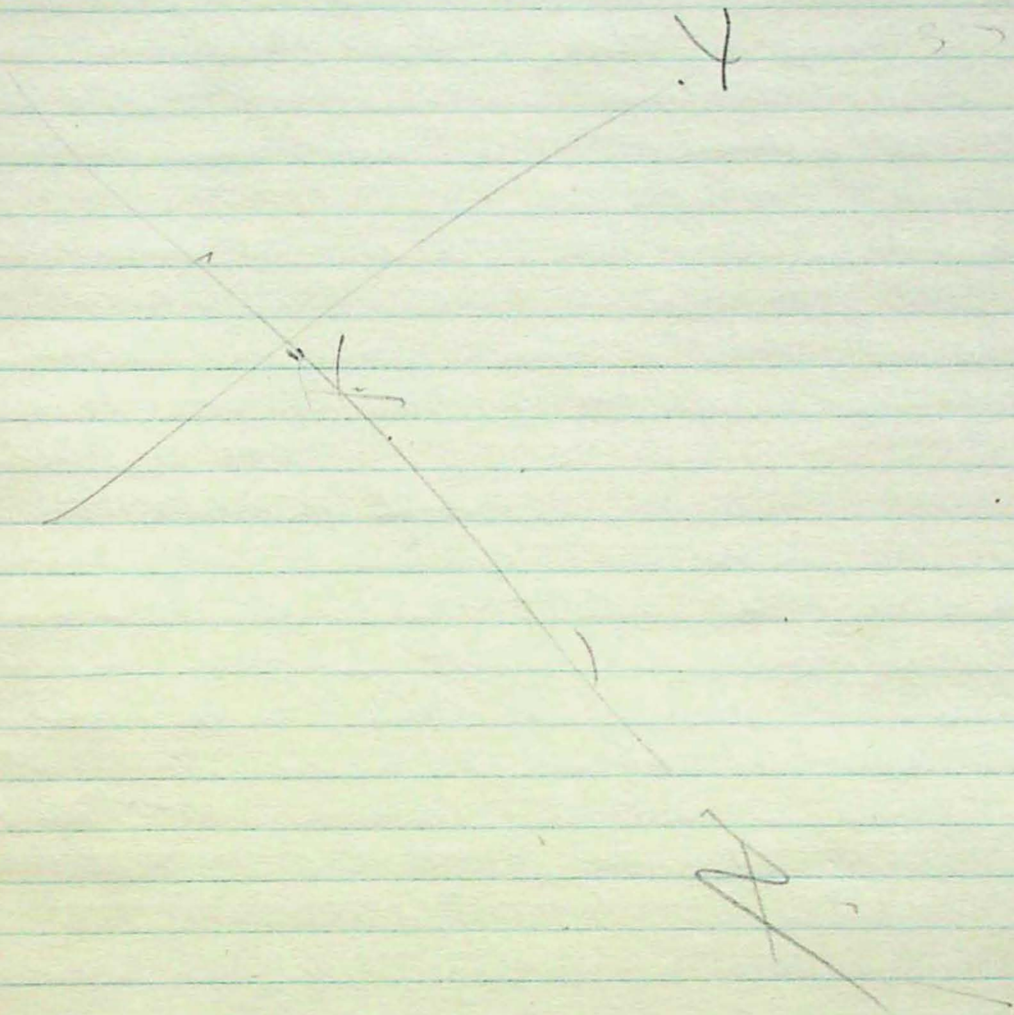
General characteristics of deformed rocks

339 16↑

68 0

328 3↓

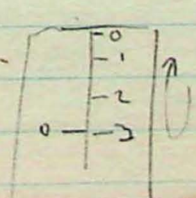
Y/Z 45↓ (0 0)



Z 345° 15½ ↑ 010 270 10↓

Y 251 — 11 ↑

24½ ↑



214 B

In metamorphism whether deformation occurs or not the mutual relations of the xls as shown in the microfabric are determined by complex process of xl growth & solution in a medium which remains essentially solid

Becke 50 years ago drew up the following characteristics of what he called crystalloblastic fabric.

Grubenmann followed Becke. Conclusions

1) The fabric is the result of the broad simultaneous growth of xls in met R.

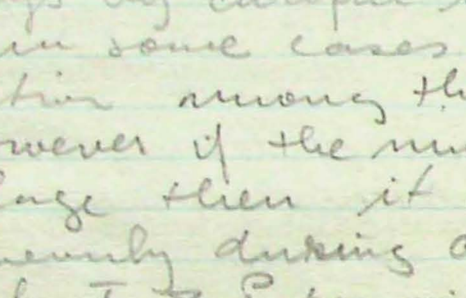
Nowadays by careful use of petrog. criteria it is possible in some cases to recognise a sequence of xlization among the met minerals of a given rk. However if the minerals constitute an equilibrium assemblage then it may be said to xlize simultaneously during a period of metamorphism in which T & P remain within rather strict limits

2) Xls may be irregularly bounded i.e. xenoblastic or bounded by regular faces: idioblastic.

Well developed faces are usually simple forms. and often ∥ to cleavages

Anfibolito e dioritos similares mineralogicamente podem ser distinguidos com base em 2

igneous anfibole/típico



It is sometimes possible to distinguish minerals being metam by its habit

Ex met hornbl tends to occur in long prisms bounded by 110 with ragged termination

met. feldspar are almost always xenoblastic

3) Large xls of met minerals (porphyroblasts) commonly show a sieve structure. They include small grains of preexisting minerals which remains stable under met conditions and have not contributed to the growing porphyroblast.
4) In xists there is a strong tendency for tabular ~~xls~~ and prismatic xls to show some parallel alignment of the long dimensions. This imparts a xistosity (synonyms, foliation) sometimes called flow cleavage, on the assumption that the xls assumed their orientation during xlization accompanying plastic flow of the rock.
5) Met minerals can be arranged in regular sequence; crystalloblastic or idioblastic order or series. Minerals high in the series (rutil garnet) always tends to develop better forms.
Eskola and Fairbanks ~~[illegible]~~ that there is a close relation between the type of xl struct and position in idiobl series. From high to low in the series we have 1) the silicates with SiO_4 tetrahedra isolated (3) [illegible] 3) sheet str. silicates 4) tectosilicates. This is also an order of decreasing denseness of packing of component ions.
It would seem that the main property which determines whether a xl face shall develop in a met min is the surfface energy of the particular face of the xl lattice in question (pg 510, 511, 512). High surf energy is characteristic of densely packed ions ‖ to the surface in question. Dense packing is characteristic of the orthosilicates as contrasted with tectos.
For any one mineral the simplest xl faces 100 110 etc have the highest surface energy and

is ∥ to these that cleavage also tend to develop. Obviously many factor must play a part in determining the nature of grain boundaries in met ~~rx~~. Ex: differences of porosity and permeability in ≠ direction in a rock, variation of P, T and concentration of pore solution. However the fact that there is any cristalloblastic series shows that surface energies determined by xl str. are the most important

In addition to the above there are certain characteristic features of the fabric of met r. The first is the state of preferred orientation of the constituent mineral grains most obviously is ∥ alignment of elongated or tabular xls. It gives the state of pref orient according to grain form or shape (Regelung nach Korngestalt)

Perhaps more fundamental is the orientation according to internal str. of the grain brought out by fabric analysis. Here we have pref orient of some crystallogr direction or plane such as c-axis of quartz or calcite or 100 or 010 plane of albite in some direction of the rock { Regelung nach Kornbau or Gitterregelung (lattice orientation)

This is obvious evenly when xl outline are quite irregular

Qual o mais importante. P. ex o que controla a orientação da mica; o C-axis ou o plano normal de elongamento do xl.

∥ Surfaces of inhomogeneity are usually obvious in deformed rocks. Sander descriptively groups these as S-surface (mnemonic for schistosity-shiefer). The term schistosity or foliation may be used as equivalent. The term ~~sx~~ cleavage is sometimes applied especially if there is

Xistosity is usually marked by parallel allignment of tabular minerals or by ∥ layers of ≠ mineral comps. or by surfaces of differential movement or by layers of ≠ grain size or any combination of these

≠s in ~~major~~ comp from layer to l. may be inherited from original bedding ~~but~~ may equally well, devellopped by met. differentiation

3 - Lineation. It is a kind of linear grain within the principal foliation surface. It is due to ∥ alignment of micas, amfiboles, to intersection of several sets of S-surfaces, or to microfolding (microcorrugation) of foliation the fold-axis being ∥ to lineation

Lineation may be much stronger than foliation an the rocks may brake as elongated pencil.

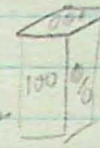
4 - Joints - both microsc and macr. usually hold some simple relation to foliation and foliation. Particularly characteristic are the cross joints (Q-joints) approximatly ⊥ to main xistosity and lineation

284 methods of identifying minerals

(Morphological data

Coordinate angles. Em cristais p. ex com 6 faces não paralelas a simetrics seremos 12 interfacial angles mas n(n-1) = 30 d's angles 12)

p. ex romboedro

Cristais subdesenvolvidos 

faces simples não adeantam no metodo morfologico

Isometricos tambem

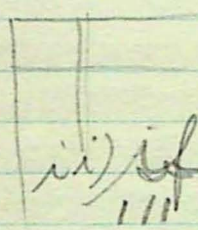
— ~~A orientação~~ The setting for orientation pode ser feita seguindo certas regras. As Barker rules são boas

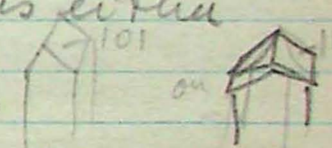
Barker rules

regra of the simplest indexes

i) Choose the setting that gives you the maximum number of simple planes (com números 1 e 0) (no hexagonal até 2)

As vezes existe apenas 1 meio de resolvelo



ii) if we have setting which give us either 111 or 101 prefira-se 101 Ex apof. apofilita → 

↑ preferida

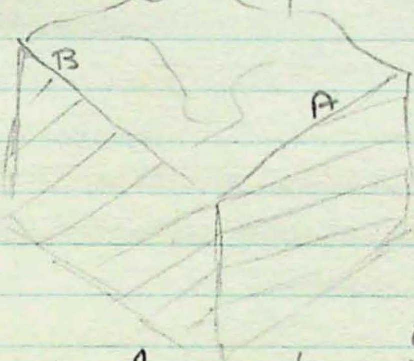
iii)

Plunge - Qualquer [?]

PROBLEMAS de Goniometria em Geologia Estrutural

Todos os elementos são projetados no hemisfério inferior. Projeção usada [?]

1: Dadas as direções de 2 secções verticais (A N30E) sobre as quais se mediu o mergulho aparente de uma determinada estrutura (Em A 30° p NE; B 50 p W) saber direção e mergulho verdadeiros da estrutura em questão



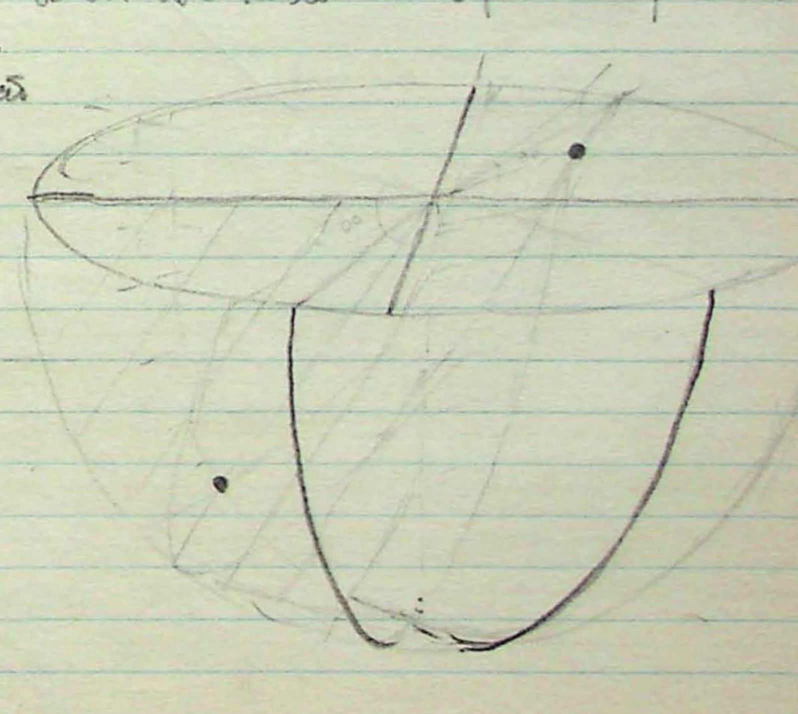
Sol.

Evidentemente a estrutura é planar mas para a solução parcial de cada secção consideramos 2 estr. lineares hipotéticos. Na secção A o elemento linear é pouco inclinado, 30° da horizontal. Após traçar-se a projeção do plano A na rede. A partir do circulo equatorial, contamos 30° para o centro do circulo, sobre o plano representativo da secção A. Esta operação nos dará o ponto de emergência do elemento linear da secção A no hemisfério inferior da esfera.

2 Repita-se a mesma operação usando os dados da secção B.

3) Unam-se os 2 pontos de emergência dos elementos lineares por circulo max. Isto nos dará o traço da intersecção na esfera, de um plano que conteria ou melhor, seria paralelo às duas estruturas lineares. Este representa a verdadeira estrutura planar procurada.

A intersecção desse circ. max. com circ. eq. nos dará a direção da estrutura planar e seu mergulho sendo contado a partir do circulo equatorial ao longo da normal ao plano.



Solução
N 49 E
mrg 60° NW

(camadas, juntas etc)

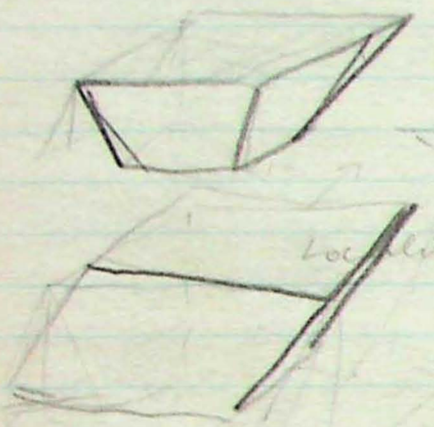
2) Dados, direção e mergulho de 2 estruturas planares
A) N 72 W merg N a 55 — saber direção e mergulho
B) N 20 W " SW a 35 — verdadeiro (plunge) da aresta de intersecção

Etc

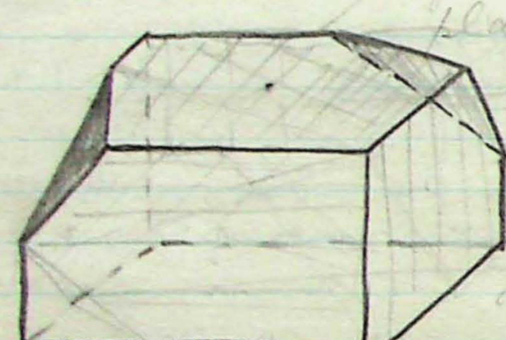
Foram obtidas 2 amostras de xisto colhidas em localidades S_1 ... A 1ª S1 ~~foi polaridade~~ foi encontrada no campo c/ orientação N 25 W a merg 50° N sobre a superfície de xistosidade, e mostrava 2 estruturas lineares L_1, com pitch de 30° para o Norte e L_2 com pitch de 20° para o Sul.
A 2ª amostra S_2 tinha orientação de xist EW e merg 30° N ~~e só apresentava 1 lineamento~~ L_3 com pitch 57° para W

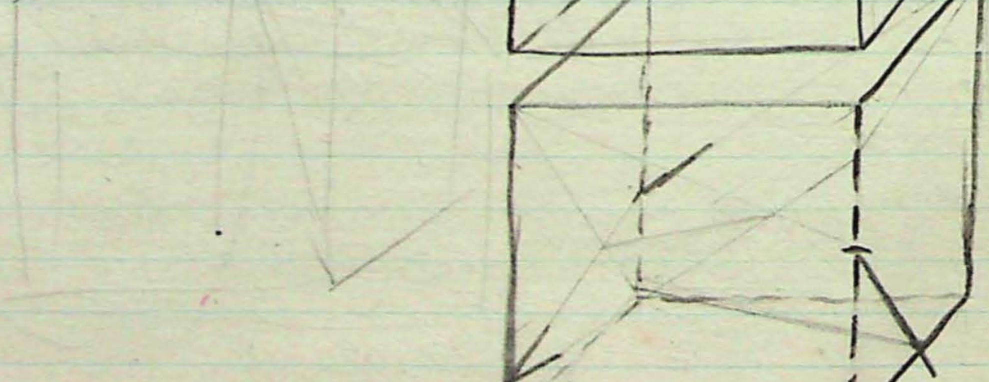
Localizados os lineamentos

Saber se o lineamento L_3 corresponde ou não a um dos lineamentos L_1, L_2 da amostra anterior



~~A marcha~~ seguida para localização dos lineamentos é a mesma que para o problema 1. Apenas aqui temos estruturas planares inclinadas e não verticais. Assim, torna-se necessário localizar 1º os polos dos planos de xistosidade e depois traçar a zona normal a esse ponto que dá a linha de intersecção na esfera do pl de x. Sobre essa linha e a partir do equador conta-se o ângulo dado para os pitches





4-3-1953

214 b pg 560.

Outline of the essential problems in Struct. Petrol

During the past 20 or 40 years applications of Sander technique to the study of rock fabric in different parts of the world has led to recognition of a number of standard patterns which tend to appear in metamorfically deformed rxs. Presumably deformation has followed standard patterns, and the problem is therefore to interpret the fabric data either dynamically in terms of stress or kinematically in terms of movement. Some aspects of this problem were recognized long ago by men such as Van Hise Leith and mead (Wisconsin) Becker, Albert Heim (Switzerland). They were concerned particularly with the dynamic interpretation of foliation or xistosity (pg 561)

There are now 2 profitable lines of attack the prob

1) To do very intensive fabric analysis (including analysis of the field data) in areas, the deformation of which is thought to be well understood. Method followed by austrian school and mc Intyre in Edinburg

2) Lab deformation of minerals & rx under controled condition (approximating geol. cond) should give results which might be correlated with natural fabrics - Griggs e [illegible] Fairbairn

Although this 2nd line of approach has not yet been carried far it is perhaps best to start with this aim in attempting to summarize problems of Str. Petr and the extent to which they have been solved para explicação de termos em petr. estr.

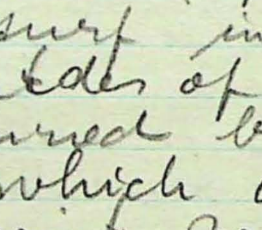
Sears	Mechanics heat & sound	1950	pg 236-251	
Lindsay	Physical mech	1950	299-315	
Turner,	pg 390, 391, 517-518			
Griggs	"Creep of rocks" J.G.	v47	225	1939
"	"Experimental flow"	v51	1001-1021	1940
"	Miller "Def. of Yule Marble" GSA	v62	853-862	1951

Definitions & concepts.

When an external force (syn: stress or directed press) is applied to solid body, it is transmitted & redistributed through the body. At any point, in any stress surface in the stressed body these redistr. forces can be expressed in terms of 2 components namely; a normal stress compression or tension directed at right ∠ to the surf.

The 2nd comp. is the shear stress acting in some direction ∥ to the surf in question

~~Stress 2~~ The magnitudes of these 2 comp are ~~[illegible]~~ determined by the 3 mutually ⊥ principal stresses x_1, x_2, x_3 which can be shown to operat at any point within the stressed body normal to the 3 planes of zero shear-stress



When x_1 x_2 x_3 tensores

pr hydrostatica ou confinante

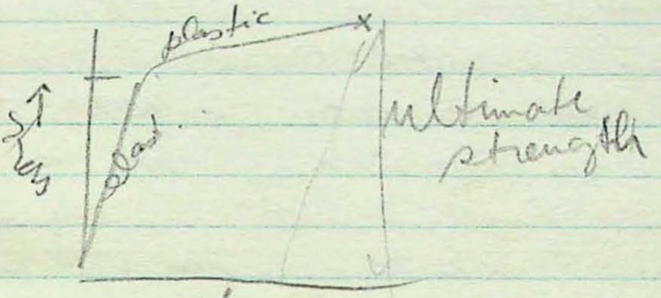
em fluidos

In a fluid the coherence of the component molec or ions is insufficient for appreciable shear-st to be maintained at any point. Every plane at any point is a plane of zero sh-stress.

The principal stresses are equal and the same at any point in the fluid

The value of x_1 or x_2 or x_3 ~~are~~ is then known as hydr pr or conf pr or simply pressure.

Any solid body which is subjected to an externally applied stress changes its shape and ~~dimension~~ volume. Some of these changes are named strain



In the case of tests for metal bar it is convenient to plot the relation between strain and stress when stress rises, at 1st there is slight elastic st which is reversible on the release of stress. Then at a fairly definite point the "yield point" a much more marked irreversible plastic strain sets in. This yield point depends very much on T.

It terminates in rupture, as the specimen pull apart on the surface of the highest sh-st ?

The above diagr is typical for such subst as metal which are termed plastic, malleable or ductile. Ionic crystals and crystalline aggregat such as garnet, qz, olive in ord. lab conditions are said to be brittle. They show little or no plastic strain but instead elastic strain leads almost directly to rupture

The above discussion is based on exp. of engineers and physicists

The usual cond of the lab tests are low pr and in many cases low T and short duration of applied stress. In these respects the lab tests differ remarkably from natural deformation. This is important because such properties as elastic limit, ult. strength and plasticity are greatly influenced by T, conf. P presence of pore fluids and duration of stress.

214 b

2ª feira field work
Brunton, esparadrapo, martelo

Flow & Fracture

From the contrast between the plastic behaviour of metals and the brittle beh " of materials like concret in the lab, some geologists developed the idea that in the crust there is an upper zone where rocks are brittle and a lower zone of high P T where they are plastic. i.e. zones of fracture and flow. Joints obviously are fracture effects Schistosity is in many cases clearly an effect of flow although a heterogeneous rock cannot be ~~deflect by~~ is said to be plastic in the same way as ~~a the~~ is xl of metal.

Certainly extensive flow in the deep level is demanded by the theory of isostasy. We recognize however that in most met regions deformation has involved both flow & fracture contrasting the brittle behaviour of dolomite & plastic beh. of marbles.

Plastic ~~flow~~ deformation of single crystals

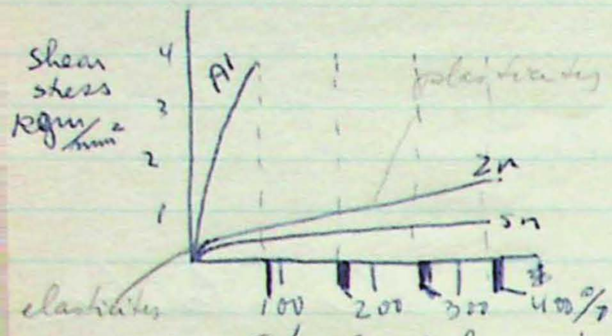
1- metals

C. Barrett 2nd Structure of Metals 1943 pg 288-316)

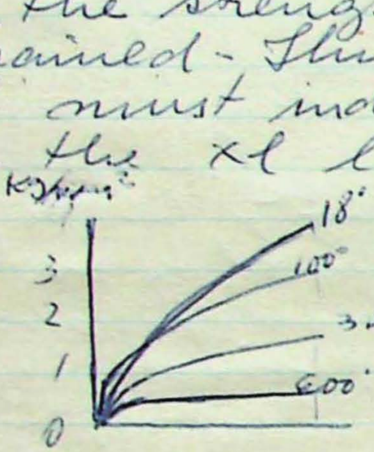
Andrade (Viscosity & plasticity 1957

Symposium on imperfections on nearly perfect xls

Mott Nature vol 171 534-537 1953 strength of solids.



For most or all metals at ordinary T a small amount of elastic strain is followed by very much greater plastic strain after the yiel point is reached. Beyond this point, the slope of the curve indicates a steady increase in the strength of the crystal as it becomes strained - This is known as strain hardening. It must indicate some internal change in the xl lattice



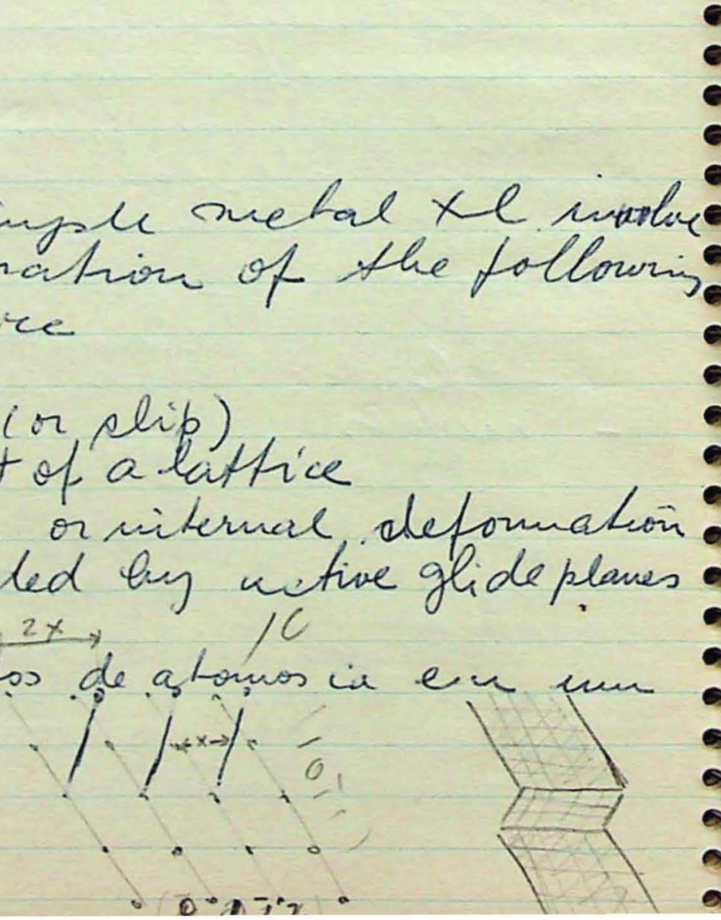
With high T the yiel point is lowered

Plastic flow of a simple metal xl involve any of a ~~simple~~ some combination of the following 3 processes in the lattice

a) Twin gliddings
b) Translation gliddings (or slip)
c) Rotation of all or part of a lattice

c), may involve bending or internal deformation in a area of a lattice bounded by active glide planes

lattice Twin gliddings. supondo apenas os ligamentos de atomos ia em um plano ⊥ x, 4 ou 3 || a W



Fairbarn →

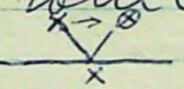
It takes greater stress to deform any more

Tw. glid is a lamellar movement taking place ‖ to a given plane; the twin plane which is also the glide plane and also ‖ to a given direction; glide direction in the Xl lattice.

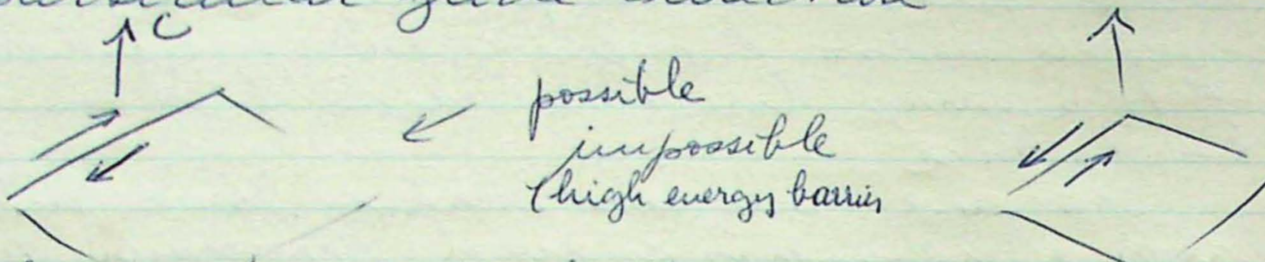
The necessary condition is that when one layer of ions has moved through a certain fraction of interatomic distances it reaches a stable position in relation to the layer of ions above & bellow. For such stability the layer that has moved is twinned in relation to the fixed layers

In a twinned lamella so formed this small lateral movement is integrated through million of layers so that the twin lamellae may have a thickness of 0.5 mm

The diagrams usually given to represent twin gliding are far too simple for even the simplest cases of tw. glid in ionic crystals. They represent points through ~~points~~

There are very special requirements for twin gliding. 1st) The glide plane must be a possible twin plane in the lattice. This means that this cannot be a plane of Xl symmetry. It must be a plane such ~~that~~ there are two alternative positions symetricaly with reference to tw. plane in to which each ion may fit with equal ease  2nd) It must be possible for an ion to move readily from one position to the other along the glide line & glide plane. ~~Its~~ path of possible movement can be regarded as energy trough between the 2 energy depressions which are the alternative sides for the ion in question

~~for a particular glide d~~ Gliding usually occurs in only one sense for a particular glide direction



Finally note that if twin gliding of one set of planes is carried through to completion the end product is a lattice which appears to be untwinned. The crystal can be deformed no further by twinning on this set of twin plane.

Assim não podemos ter certeza num marmore se a presença de twin quer dizer ou não que o processo não começou ou já terminou. Por outro lado quando se vê só fina lamela será que é só a fita que está começando a geminar ou é todo o xl que já geminou deixando somente ~~alguma~~ (cristais finos) não geminados?

Although the amount of deformation for tw. gliding on one set of planes is limited it is very effective in changing the orientation of the xl.

Twin on 01$\bar{1}$2 em calcita muda a orientação do c axis em 52°

~~Em~~ crystal fabrics this ≠ of orientation in twin lamellae is brought out by differential etching by acids.

Em xl de metal com face centrada os planos possíveis de tw glid são 111 (4 planos e 112 (12 planos)

Medida de Z/c em pyroxenios.

Se o pyroxenio não possuir geminação, o melhor processo continua sendo o da observação em platina comum sobre figura de interf. centrada (flash fig.) Isso porque a medida de clivagens em pyroxenios é sujeita a erros muito grandes e as posições de x, y, z são sujeitas tambem a desvios devido à falta de extinsão perfeita (dispersão relativas forte)

Entretanto em muitos ~~nos~~ anfibolios que possuem em geral clivagem bem mais distinta e menor dispersão o processo de simples projeção dos elementos dá bom resultado.

Quando porém o pyrox é geminado pode-se obter Z/c com extrema exatidão desde que se façam as leituras com cuidado.

Segundo o processo abaixo não é preciso projetar os polos de {110} nem achar a emersão de c

É a seguinte a marcha seguida

1) Coloca-se Y, que é coincidente nos dois individuos ∥ ao eixo E.W. Os dois individuos devem permanecer extintos durante a rotação de E.W.

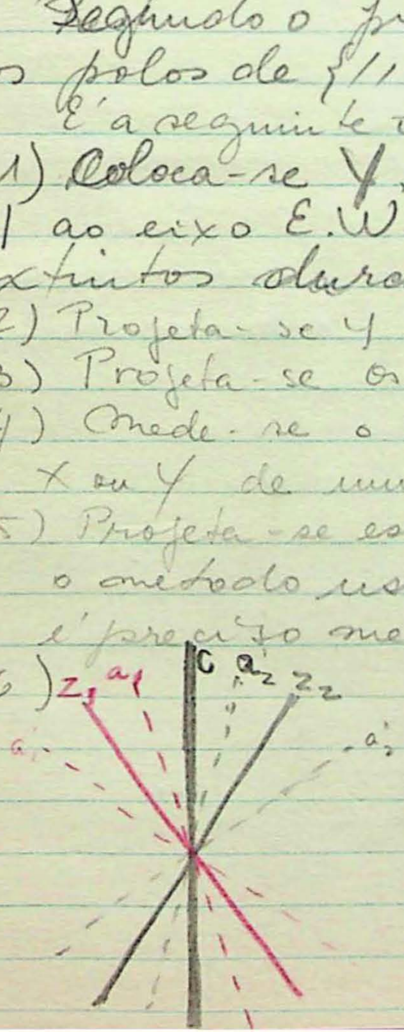
2) Projeta-se Y na rede

3) Projeta-se os E.O. que apareceram dos 2 individuos. a_1 e a_2

4) Mede-se o melhor possivel uma das outras 2 direções X ou Y de um dos individuos.

5) Projeta-se essa direção sobre a zona ⊥ a Y segundo o metodo usual. A 3a direção será colocada a 90° (não é preciso medi-la

6)



$$2(Z_1 \wedge C) = 2V + a_1 \wedge a_2$$

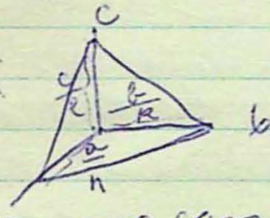
Conhecidos 2V e $a_1 \wedge a_2$

284 — Identificação óptica
Líquidos

X-ray — Ver Rogers para entender o powder pattern
Introduction to the study of minerals.
Tables 4.200 substs
Pode-se estudar qualquer min mesmo monometricos.
Pouco material. Precisa-se porem muita pratica ou sorte para reconhecer e diagnosticar impurezas que afetam o powder pat.
Além disso o X Ray process é mais demorado.

(powder pattern)
Como se pode estar certo que as linhas no p-p correspondem a certas distancias interplanares no reticulo
caso nos ortorromb.

$$\frac{1}{d^2_{hkl}} = \frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}$$

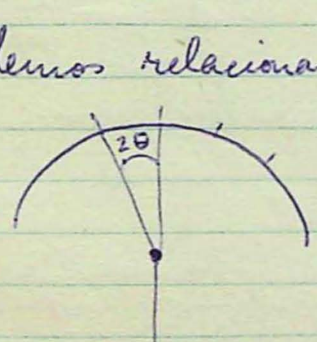


a no caso do monometrico

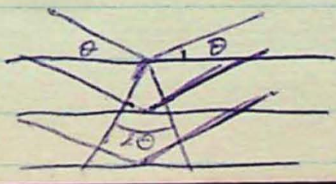
$$\frac{1}{a^2} = \frac{h^2+k^2+l^2}{a_0^2} \longrightarrow \quad e \; d_{hkl} = \frac{a_0}{\sqrt{h^2+k^2+l^2}}$$

se $hkl = 100$ $\quad d_{100} = a_0$

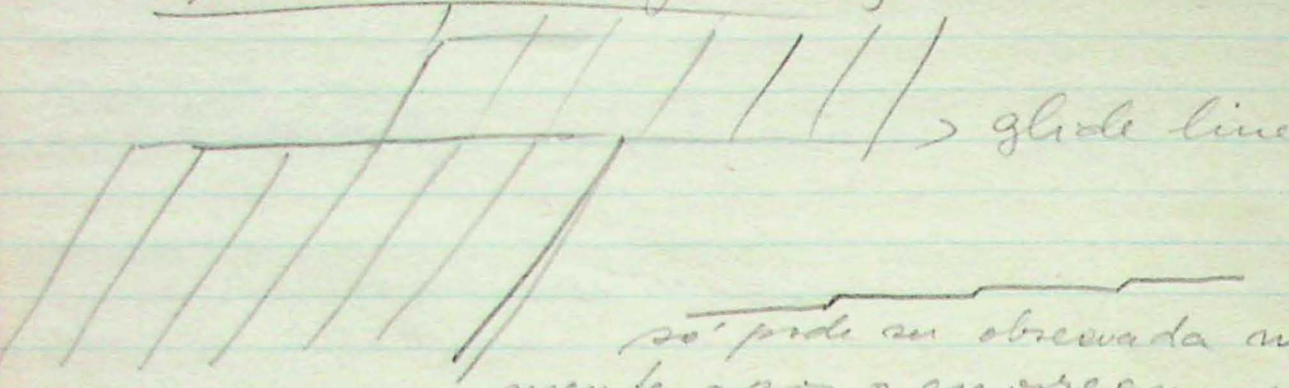
podemos relacionar indices com espaços interplanares



Bragg diz diffraction é devida a reflexões nas camadas



Translation gliding



só pode ser observada macroscopicamente após o escorregamento ter afetado alguns milhares de layers. A estrutura não é afetada

Here we deal with lamelar motion of layers ∥ to a slip or translation plane & in a definite slip ~~dir~~ glide direction. São também planos de índices simples no lattice. The theory is that one layer slips through a hole number of interatomic distances, perhaps a thousand of such dist in average. The lattice then locks.

Although the xl is deformed the lattice is not. Where the gl. planes intersect the edges of the xl, slip lines appear on the surface. They represent minute steps. In many cases they are regularly spaced, one micron appart. It is possible the movement to occur on either sense of translation.

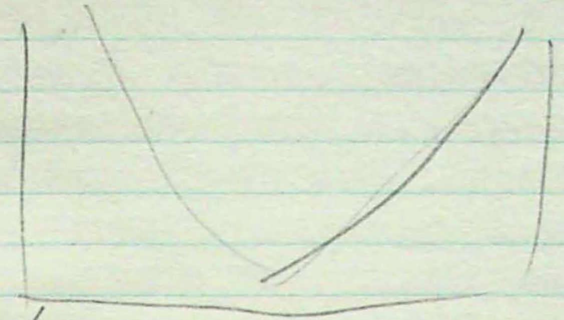
It is possible to calculate the amount of shear stress

shear stress coeficient

For either type of gliding the result shear stress may be calculated

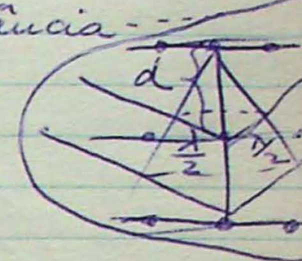
$\sigma = \cos \varphi \cdot \cos \theta$

O máximo coeficiente é atingido quando a força (tensional ou compr.) age a 45° $\sigma = 0.5$



For stress = σ
Above a definite yiel point a single xl will deformed rather rapidly by translation. If a much lower stress is applied for a long while it may also yiel very slowly by creep

"reflexão" ocorre somente quando essa distância ---
corresponde a 1 nº inteiro de λ



d

$$\frac{\lambda / 2}{d} = \sin\theta \quad \text{(por construção geométrica)}$$

$\therefore \lambda = 2d \sin\theta$ $\qquad \lambda = d_{hkl} \sin\theta_{hkl}$

certa dist. $\qquad$ certo ∠ para refl no plano hkl

A situação geral é

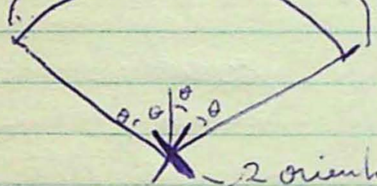
$$n\lambda = 2d \sin\theta$$

Temos 1ª 2ª ordem etc (para certo λ) dependendo do valor da distância --- ?

Referiremos à refl 1ª ordem ex 111
" " 2ª " ex 2(111) ou 222
" n " n(111)

Generalizando $n(hkl) = nh\ nk\ nl$

No pó temos todas as orientações mas só aquelas pedaços mostrando orientação a ângulo 2θ conveniente produzem reflexão que naturalmente será circular pois temos infinitas posições a ∠ conveniente x ----  ou —— 



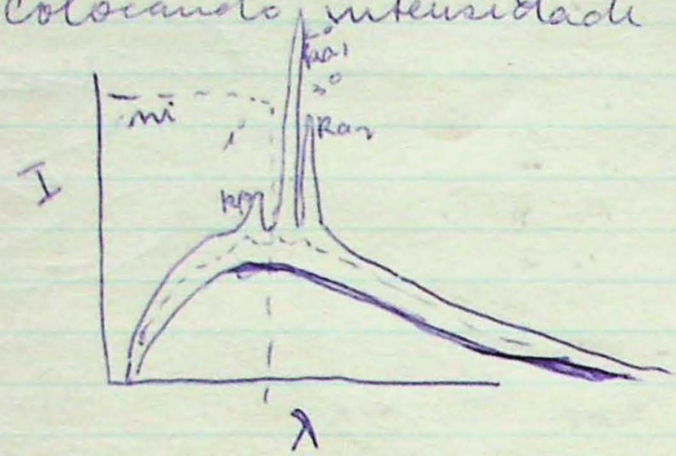
$\lambda = 2d \sin\theta$ $\qquad$ Precisamos conhecer λ

histórico — se conhecermos d poderemos

Bragg (supôs) assumiu d medindo fora do Rx, densidade, peso e volume exato de NaCl.

Hoje em dia podemos medir diretamente λ em gradings

Colocando intensidade (dada por voltagem) com λ para (o caso do) cobre



Há certo valor de potencial onde a curva começa a modificar em picos, - -

Em cristais fixos θ é fixo e para cada d e para cada plano especial haverá um determinado λ. Daí o Laue pattern

Podemos mudar θ movendo o cristal e temos o rotation pattern

Os spots que se conseguem (ver graus acima) podem ser devidos ao 1º pico fracos ou ao 2º e 3º que coalescem geralmente e dão spots fortes. Chamamos ao 1º pico K_β e ao 2º K_{α_1} 3º K_{α_2}. Essas radiações estão ligadas à constituição eletrônica dos shells dos elementos. e aumentam com a descida na escala dos elementos. Mas usamos tubos que só produzem K radiations. O Ni que está logo antes do Cu na escala de Mendelejeff absorve porém as radiações K_{α_1} e K_{α_2} e assim, um fino filme de Ni pode ser posto no trajeto do RX para obter resultados.

Pode-se também monocromatizar os raios com a interposição de certos cristais, antes dos cristais a investigar.

	2V	Z/c
Augite		
	58	41 ½
	52 ½	44
	55	43 ¾
	54	43
Hypersthene		
	61	
	61	

Transl (concl)

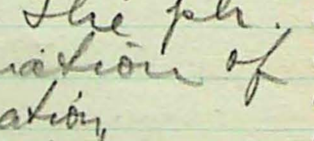
For any particular experiment whether a xl will deform by transl gl. or by twinning or by rupture along a cleav. depends upon the relative intensities of the resolved sh-stress acting in a potential glide plane or gl. direction and the normal tensile stresses acting at ⊥ ∠s to potential cleavage and on the relative resistances of the xl to translation, tw. & rupture. These last 3 properties varie with T.

Significações da deslocações no retículo.

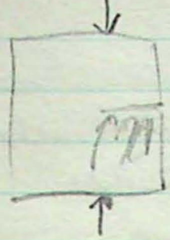
Barret book

The simple theories of slip (just seen) fails to explain many of the phenomena of xl deformation P. ix 1) On the basis of that theory it is possible to calculate from the elastic constants of the xl what would be its resistance to slip in various directions. The calculated strength is found to be 1 - 10.000 times the observed straight

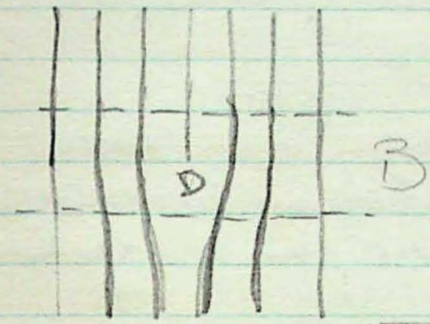
2) The phen. of strengthh hardening 3) The ph. of creep, that is permanent deformation of a xl under long continued application of a stress well bellow the yiell point



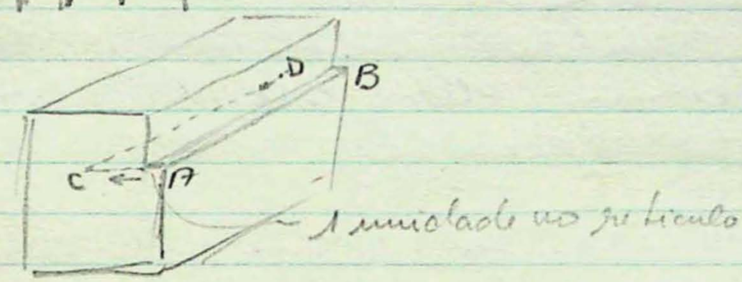
To explain these dificulties 25 y. ago Taylor & other appealled to the presence of imperfections in the xl lattice. It had already been shown (experimentally) that the stress within a xl is greatly encreased in the inmediate vicinity of a minute crack in the specimen



It was argued that faults(?) in the lattice might locally increase the stress many times as well as contribute indirectly to its fail
So it was invented the theory of dislocations

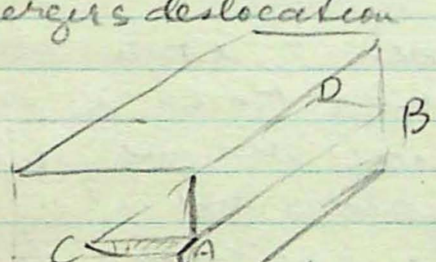
1) 

Por interrupção casual de 1 camada as outras tendem a compensar a falta por desvios ligeiros até restabelecer normalidade mas forma-se 1 zona de fraqueza e desordem em B

2) 

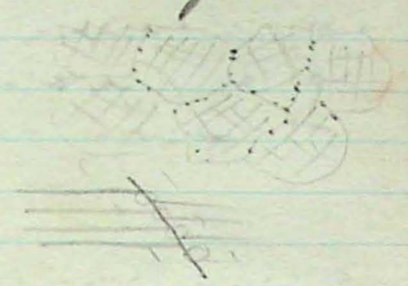
A dislocation is a linear imperfection in the xl. It is as if a line of unoccupied atomic spaces had developed in the lattice. A common case is where the dislocation lies ∥ to some simple xl direction. In the immediate vicinity, structural of the lattice is remarkedly strained. Rectilinear dislocations have been described in terms of imaginary slip within the lattice. P. ex em 2) CD is dislocation at could conceivable be formed by slip on the plane ABCD ~~carrying~~ carried halfway ~~through~~ the xl in the direction AC.

Buerger's deslocation

3) 

In 3) we have slips carried on plane ABCD but ~~in~~ the direction AB

There are more general kinds of dislocation than the simple rectilinear types. It is now thought that in ordinary xl is built up of a mosaic of blocks ~~differing very slightly~~ which are separated by closely packed lines of dislocation. Vacancies in the lattice are concentrated along the block boundaries. Moreover, the lattice is highly strained along the margins of the blocks. Dislocations are concentrated also on the xl surface.

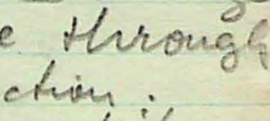


Most of these disloc. probably develop spontaneously during the growth of xl. Indeed, it may be necessary to the growth of xl.

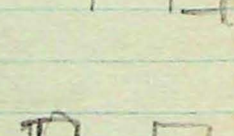
Difusão de ions tb deve ser explicada como ocorrendo ao longo dessas separações

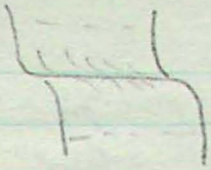
---

If a xl containing disloc. e aplied stress it can be shown by calculation that 2 things may happen 1) The disloc. may move through the xl along the slip plane & slip direction. The result is slip through 1 interatomic distance. The calculated stress is very small =



2) If the stress is somewhat larger, new disloc may develop near the surface. They will then move through the xl to the opposite surface

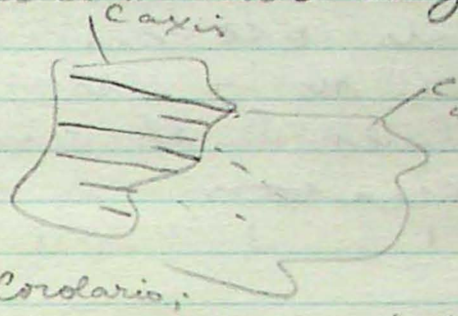


It is thought that when a series of dislocations have passed along a slip plane the strength (of strain?) colectively built up near this slip plane is so great that no further disloc will develop. For further deform. of the xl new disloc must be initiated. This partly explains strain hardening and also the appearance of slip lines  ← muito deformada. Novas deslocações só em outros planos

According to this theory, the essential condition for plastic flow is migration of a center of disorder i.e. a dislocation ~~to~~ through an otherwise ordered environment.

The driving force to the migration is supplied by this ≠ in order (local ≠s in entropy) along the ~~block~~ block boundaries of the mosaic the constitutes the xl there is an high concentration of disorder.

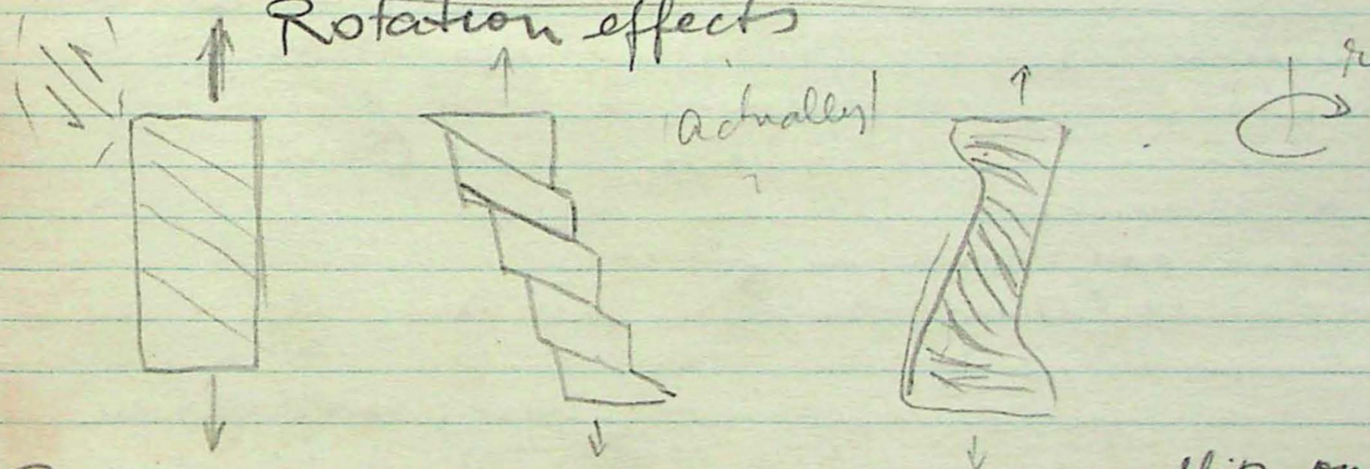
This may form a barrier through which dislocation cannot pass unless stress is increased. This also contributes to strain hardening



Corolario:
xl é menos resistente que seu agregado. marmore + resistente que calcita

Read, Shockley
no livro on Imperf of nearly perf. xl.

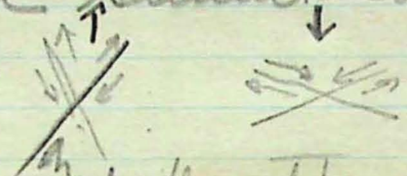
Rotation effects



~~Rotation~~ If a single xl yelds ~~by~~ slip on a single ~~single~~ set of planes, there is a tendency for the two ends to be latterally displaced transversed to the axis of compression or tension.

An ordinary lab experiment there is no such lateral displacem of the ends for these are fixed on the test machine. The deformed section of the xl therefore is rotated bodily so as to maintain the alignement of the ends. The slips planes as they rotated become more nearly ‖ to axis of rot or more nearly ⊥ to axis of compr (or tension)

Rotation may only bring to inactive slip plane into a positon where the shear stress is now strong enough to initiate slip. We now have simultaneous slips in to sets of planes smetricaly inclined to the axis of compression or tension

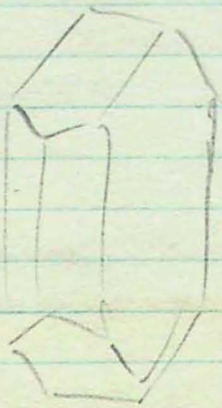


no further rotation occurs

(1) ∠ depende da cristalografia do mineral

212 Determinação de %An pela det. de twin law

2 possible composition plane



Pode ser 010, 001 ou ainda romb section
(esta quase 001 nos plag mediamente calc
021 – Ib não é muito raro especialmente
em fenocr de certas lavas

Twins tipos
1) Normal – tw plane e tw axis ⊥
2) Paralel tw – no pl mas tem tw axis
que faz no comp. plane

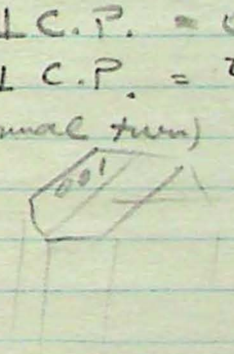
Composition plane – plano que é comum aos 2 retículos.
Algumas xx não é plano.
no Carlsbad podemos ter A (100) e B mais comum (010)

3) Complex twins –

Processo

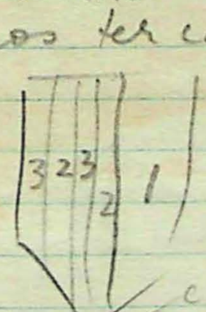
mede-se Z ∠ comp. plane (polo) curvas
se for menos de 35° é (010) se for mais de 50°
é (001). Intermediários não sabemos.
Assim CP = (010) quando Z ∠ ⊥ C.P. = 0 – 47° (certamente 0–35)
CP = (001) " Z ∠ ⊥ C.P. = 43–90 (50–90)
Intermediários são ambíguos

A) C.P. = 010
1) T.A. = ⊥(010) – albite (Normal twin)
2) T.A. = [001] – Carlsbad



dome (201?)

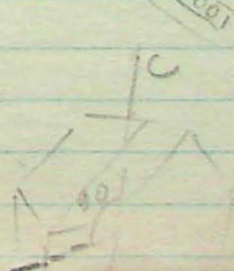
Podemos ter casos assim



	T.A.
1–2	⊥(010)
2–3	[010]

Carlsbad + Ab.

3) ⊥[001] / (010) = Carlsbad – ab

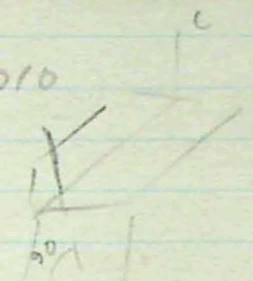


a axis

4) [100] - ala law.

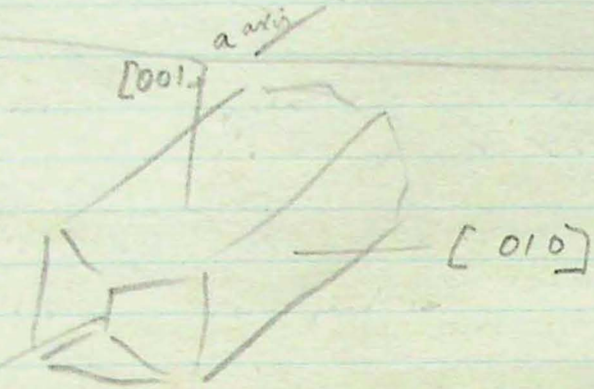
5) a perpendicular a 100 lie ou 010

$\frac{\perp [100]}{(010)}$ albite-ala



B C.P. = (001)

lamellas tw. possiveis



Ta ⊥ [00] Manebach comum

2 [100] Ala

3 [010] {Acline — não incomum
{Pericline (quando comp. pl. = r. section)

nos plag. intermediarios Acl e pericl são indistinguiveis.

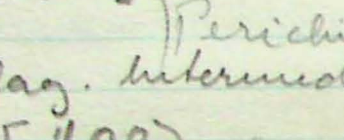
4) $\frac{\perp [100]}{(001)}$

5 $\frac{\perp [010]}{001}$

} dificeis de distinguir (4 de 3 e 2 de 5) porque os eixos [100] e [010] são quase 90°.

distinção teorica (talves goniometrias em bons xls)

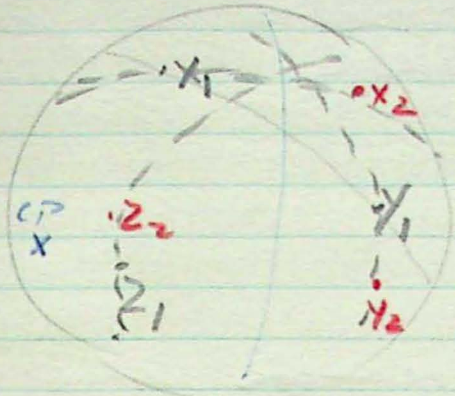
Para identificar TA. devemos 1º) pegar xls em que podemos medir 2 das 3 direções oticas em 2 individuos geminados



. 2º) deve haver outra lei de geminação cruzada com a 1ª dando uma 2º C.P. para o conjunto. não é preciso medir as direções oticas nessa 2ª lei.

3º) Projete-se X Y e Z para os 2 indiv.

Ex



4º) mede-se o C.P.

5º) Projeta-se o tw axis ~~para~~ conseguindo-se intersecção de 3 círculos (~~fazemos~~ fazemos isto porque TA gira os elementos através de 180º

6º) medimos TA ∠ X
∠ Y
∠ Z

Forma-se Δ de erro, mas tomamos a media

Ex TA ∠ X = ½ $x_1 \wedge x_2$

Para se identificar TA

1) Identifica-se o CP pelo diagrama

2) Se CP = (001) ou R.S (rombic sect)

a) Normal Tw; TA ⊥ CP

b) Parallel Tw; TA in C.P

1º) TA ∧ ⊥ 2º CP = 5º ± ∴ TA = [010] or ⊥ [100] / 001

2º) TA ∧ ⊥ 2º CP = 90º ±

[100] or ⊥ [010] / (001)

O aparelho aqui tem 4 tubos com ≠ targets dando radiações monocromaticas

radiações	Kα
Mo	0.710 Å
Cu	1.542
Co	1.79
Fe	1.93

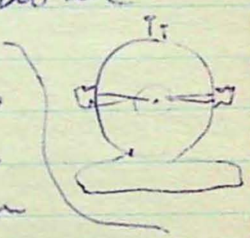
O mais usado é Cu mas certas ocasiões usam-se outros

Com o aumento de wave length sendo d constante sen θ aumenta proporcionalm e assim p. o mesmo material temos ((((·)))) ou ((·))

$\lambda = 2d \operatorname{sen} \theta$

Assim devemos considerar varios fatores

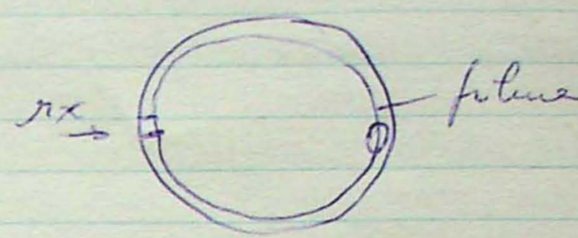
1. Resolution; long λ da maior nº de linhas
2. Limitation on d short w-lenghts dá mais linhas
3. Air scatter, isso produz escurecimento do filme. Assim usa-se aparelhos para evitar dispersão de r.x no ar. O vacuo pouco adianta no caso.

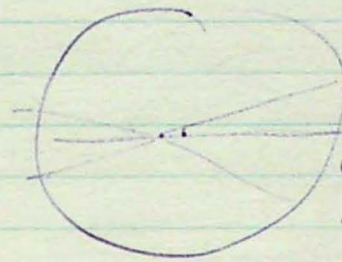


4. Exposure longer w-lengths requer maiores exposições. Exposições muito longas obscurecem ≠s entre intensidades de linhas. Porem exposição longa suficiente para frisar as diferenças é desejavel.
5. Fluorescence or absorption in preparation
Certos elementos absorvem certas w-l preferencialmente. Essa variação obedece a certas leis entre os elementos Kα é totalm absorvida para Ni e decresce para esquerda na escala de Mendeleyeff. O resultado é background escurecendo principalm quando se trata com minerais de Ti

Com Os minerais fluorescentes precisa-se tomar a precaução de colocar papel preto em frente do filme.

Camara de r-x
Tipo comum até pouco tempo



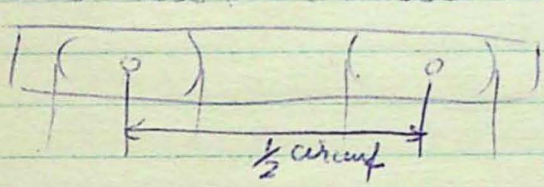


discentrado com a rotação
dá linhas largas e baças

O melhor jeito é
colocar um mineral
conhecido misturado c/ test

Q	1	Q
2θ	2θ	2θ
$2\theta_c$		$2\theta_c$
$+\Delta = 0.8°$		$\Delta_+ = 0.6°$

mede-se a circunferencia
do filme por comparação
soma e divisão entre
os pontos de entrada do rx
e linhas simetricas
(precisam ser simetricas

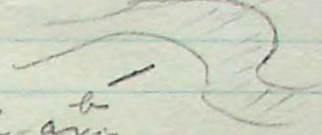


Material abaixo 300 mesh

214 b pract   b axis corresponde ao E_2 no monoclinico

Baxis assim é o eixo de dobra em dobras

que tem planos de simetria



Lineação quase sempre corresponde ao b-axis

= b-lineation

ab plane

a - axis direction in which movement has occurred

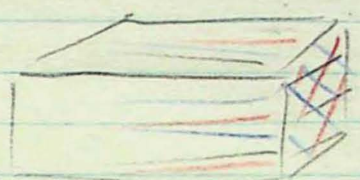
at right ∠ to the axis b

a + b = ab plane

b axis é definido por

1) axis of folding

2) axis of intersection of contemporary S planes of shear

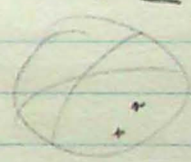


3) Elongation of xls (algumas xx é ∥ a, a)

Processo de trabalho

1) Plot S-plane (polos e traços)

2) Lineation diagram



April 8 1953

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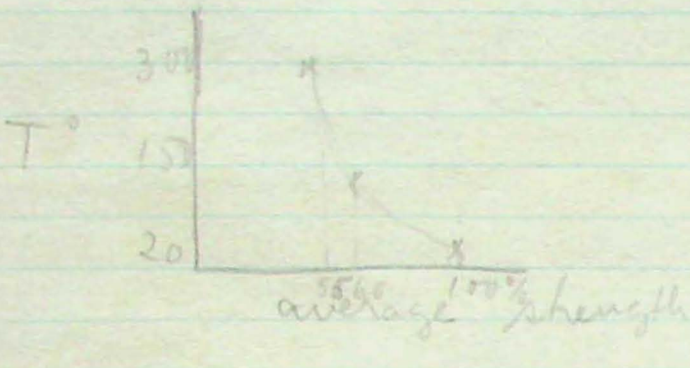
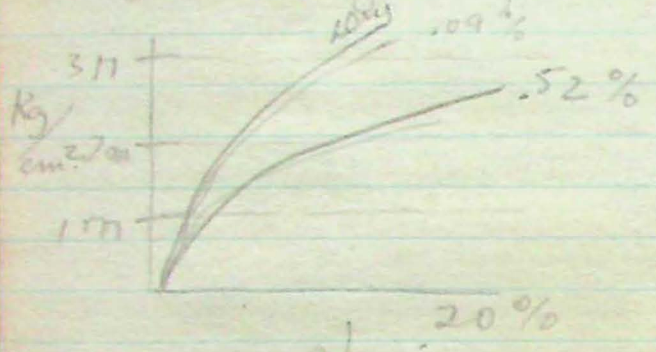


c) Presence of H_2O at high T lowers the strength for any given experiment.



(150°c)?

This could be due to recrystallization of grains or to lubricating effect. Lubrication itself must mean or involve easy movements along grain boundaries and this must mean recrystallization along ~~of the~~ boundaries

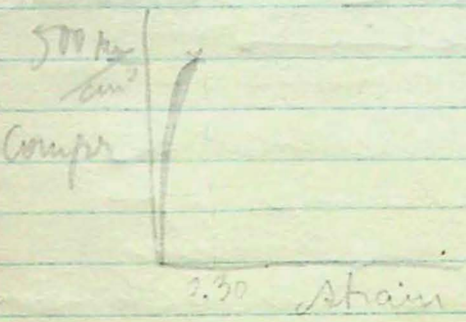
d) Effect of time was tested by comparing compression effects lasted 7 hours with an otherwise identical test lasting 1/2 hours. There was no obvious ~~d~~s in strength.

Solenhofen limest was tested at 20°c in 2 identical experiments (lasting

for 1 lb leather for 22 hours
In the former specimen ruptured at 20% compression. In the slow test it ruptured at 23% shortening This suggests that slow deformation possibly lowers plasticity. However experiment is not conclusive

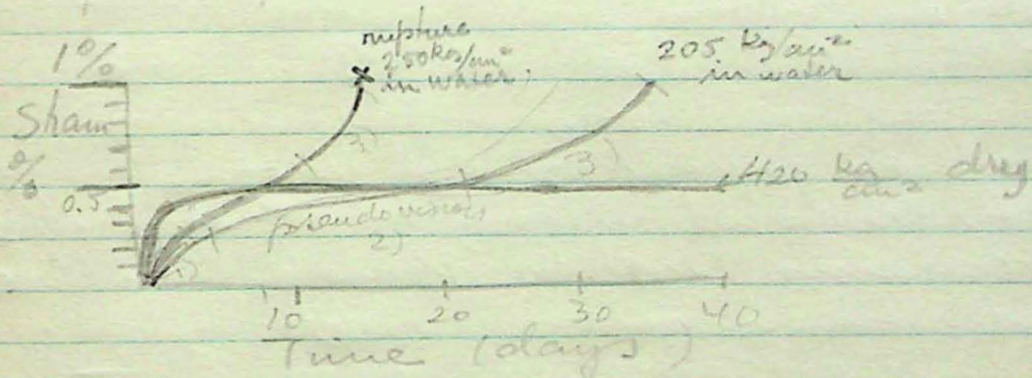
~~Jute 22)~~ 2) Alabaster

Griggs: G SAB vol 51 1940



305 250

Aplican pesos 205 kg e 250



The 3 curves represent 3 creep experim in which a column of a same alabaster → was loaded at stresses bellow the breaking strength for periods of few weeks
Note that although gypsum is relatively plastic material it would not deform extensively by creep in the dry state even

if very long time is allowed.

2) The presence of water greatly facilitates creep which now takes place under a load which is less than ½ the breaking load. The creep curves now falls into 3 parts 1) logarithmically decreasing elastic flow 2) linear creep (pseudo viscous)

3) increasingly rapid strain terminating in rupture. Griggs thinks that stage two 2) involves solution & recrystallization the stage 3) it attributes to beginning of rupture across and between the individual grains

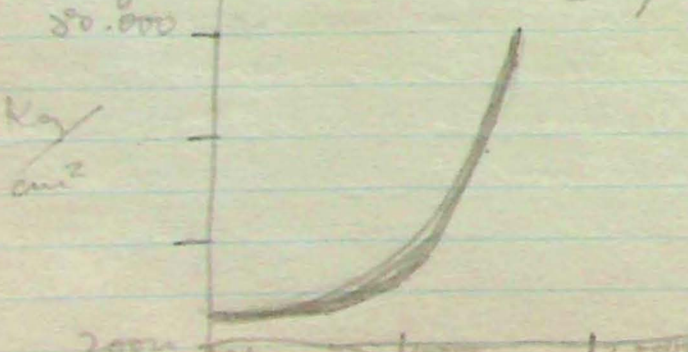
Students of metals have observed a similar curve ÷ in 3 parts for creep of single xls and xline aggregates. They explain the curve in terms of dislocation (not rexlizat—)

3) Quartz

Griggs & Bell GSA Bul v 49 1938

They experimented on single xl of Qtz.

Results a) Qz which is strong & very brittle at room T remains just as much brittle but becomes much ~~more~~ stronger at room T and absence of water at high confining pressure



b) There is no plastic strain even at high confining P

c) In the presence of 10% Na_2CO_3 solution at 400°C the strength is lowered to about 1/6 the strength of that at 20°C dry. No sign of plastic flow

Fairbairn Am Min. 35 1950, deformed closely packed angular qz sand at T of 200 - 450°, confin. P of 1 - 7.000 at in the presence of Na_2CO_3 solution. The aggregate deformed regularly by recrystallization giving sufficient time the recorded shortening 30 - 55% in times running from ½ day - 3 days

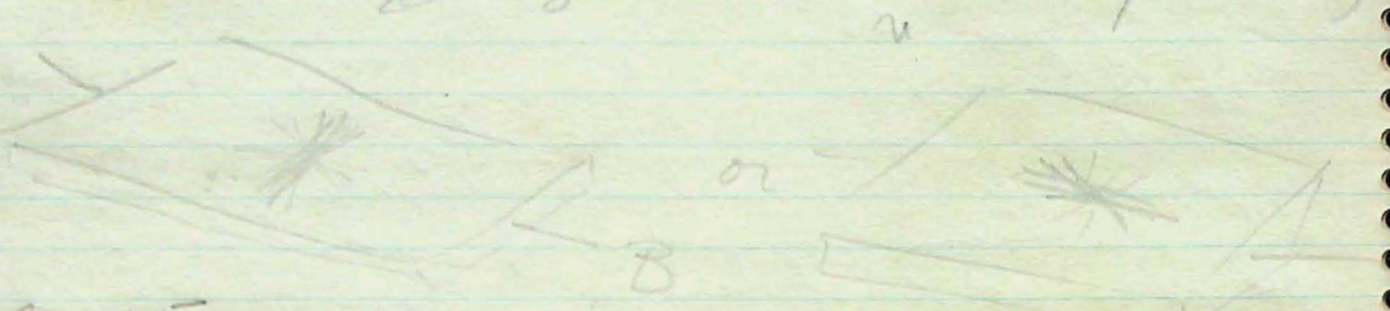
---

Preferred orientation in artificially deformed aggregates

1) Metals - During such regular deformation as drawing a wire, compression of columns or rolling of sheets, the polixline metal develops a state of preferred orientation of its component grains. The symmetry of the pr. or. pattern in general reflects the symmetry of the deforming movements. In the drawing of a wire or rolling of a sheet there is one symmetry axis as regards the deformation (this axis in either cases would be B-axis according Sander. Deforming forces act transversing the b - axis) In the 1st axis the main extension is ∥ to B in the 2nd ⊥ to B. In drawing a wire some given x-l direction will come to lie ∥ to axis of wire

Some other xl direction will come to lie in a girdle the plane of which is at right ∠ to the length of wire

Roll textures are symmetrical with regard the plane of rolled sheet and as ~~the~~ regards the axis of rolling



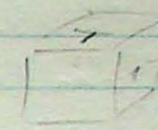
April 15

Quartzite has been produced experimentally by Fairbairn by compressing angular quartz sand under high confining press. (200-400°C) in the presence of Na_2CO_3 soln. A good foliation develops by flattening of the individual grains in the plane normal to the compression. This confirms the operation of Riecke's principle namely "solution of grains at points or surfaces of high compressive stress & elongation in complementary directions of load compressive stress. The resultant fabric resembles that of natural quartzites in lensoidal shape & ∥ dimension alignment of grains. However in marked contrast with most natural qzites there is no preferred orientation of the xl axis (optic?). The average grain size is slightly reduced after deformation.

Note that Riecke's pr. cannot applie in the following common natural cases

1) Where the grain size increase markedly (as where chert → quartzxist
mudstone - micaxist)
2) Where there is strong preferred orientation of xl lattice
3) Where the foliation is due to ‖ allignment of xls which normally have a marked tabular or prismatic habit Ex mica or Hornbl

Marble



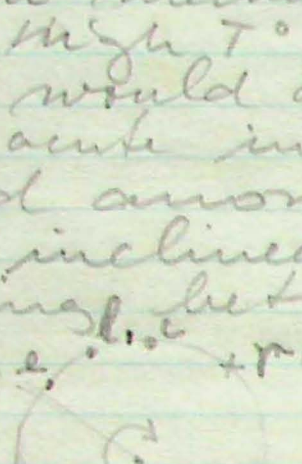
The experiments in Yule marble show that specimens which are elongated or shortening by amounts ranging from 10-20% the fabric becomes strongly modified

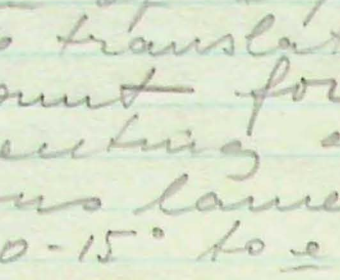
a) Grains oriented favorable to twining, ie most grains in ⊥ cilinder in tension and ‖ cilinder in compression show increasingly narrow tw. lamellae ‖(01̄12). At 20-25 deformation many of the grains are more than half-twinned. In such grains the lamellae are so closely packed that large areas of the grain appear to be untwinned although in fact they are completelly twinned

b) Where Grains which are not favorable oriented to twin Ex most grains in ⊥ cilinder in compression also show 01̄12 lamellae. These appear as sharp lines resembling strong cleavage and not recognisably twinned They tend to be most closely spaced where they are in a plane of low or zero shear stress approximately ⊥ to compression. Their mode of origin is not known. They may be due to very slight twinning or to translation but the main deformation of the grain must be due to some other mechanism (unknown)

This other mechanism leaves no visible traces except for possible internal rotation of the 01̄12 lamellae

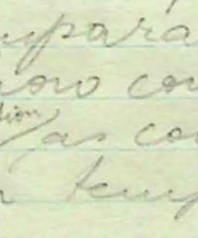
It now seems likely that the other and main mechanism of deformation (at least at high T°) is translation gliding 10̄11)
This would account for the development of acute intersecting of e lamellae and anomalous lamellae l, which are inclined 10-15° to e and its pole lying between e and c axis



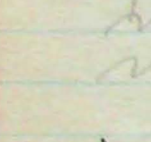


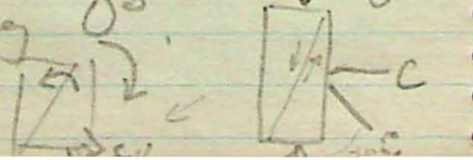
c) In the presence of water and T of 300°c the individual grains are comparable free of dusty inclusions and show comparatively little marginal distortion or granulation as compared with grains deformed at room temp.

d) In all deformed marble specimens (all T all ...) the c axis tend to be concentrated ∥ to the axis of applied compression



A grain originally having a c axis ⊥ to compression twins completely so that the c axis of the new lattice is inclined 38° to the compr. axis. External rotation of the grain reduces this angle to some value approaching 0°.



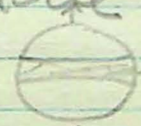


Grains with c axis originally inclined with small ∠ to compr. axis deforms by translation. This does not affect the c-axis orientation (It does not affect lattice) However there is a slight external rotation

There is also a concentration of e-lamellae poles in the general vicinity of compression axis. This concentration is especially strong if we plot only well developed e-lamellae in non-twinned grains

Edges [e ; e′) or [e_1 : e_2) between the 2 well-developed lamellae obvious in most grains tend to lie at high right ∠ to compr

For extension the c axis lie in a girdle at 90° to ext axis



Well developed e-lamellae whether due to tw. or not, have poles concentrated in the same girdle

Edges [e_1 : e_2) concentrates ∥ to tension axis

884 STIM File
muitos erros Tomar cuidado.

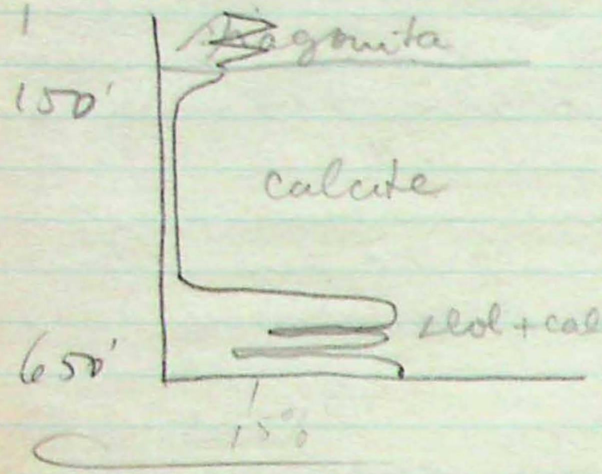
Seminario sedimentação 21 Abril
Dolomitização
B. Sanders (mto importante)
special publication (translation Knopf) of AAPG
Faust & Calaghan GSA vol 59 1948 pg 62-63

Dolomitos Origem

Original {1) Precipitação direta química (aguas altas salinas) mormas rasas.
2) Dolomitização de outras rochas carbonaticas (especial coral reefs),
Localmente
{Origem cataclastica de outros dolomitos
{Metasomatismo marginal em calcareos atravessados por veios e mineralizados

Não há evidencias experimentais explicando nem 1) nem 2)
Evidencias de 1); Fine grained não fossilíferas
? não concorda porque já viu esse tipo de dolomito substituindo coral limestone. Alem disso ele pode ser formado por replacement of fine grained non fossiliferous chemically precipitade limestone.
O idiomorfismo dos romb. de dolomita não tem importância alguma como criterio de reconhecimento entre 1) e 2) porque cristais idiomorfos não se formam obrigatoriamente em meio fluido. Dolomita (como é o caso de todos os xx idiomorfos metamorficos) pode crescer idiomorficamente em meio solido (xistos serpentina etc)
Leaching de Ca na rocha é um processo absurdo pois não se produz dolomita por leaching de calcio em rocha composta originalmente de calcita + magnesita A unica coisa que se obtem é + magnesita. Se a rocha já continha dolomita então não se explica sua formação que é anterior e não devida ao leaching. Ela é apenas concentrada durante o leaching e não creada.
Não se pode formar dolomita a partir de calcita um pouco magnesiana por simples leaching. São 2 minerais completamente diferentes sem isomorfismo entre eles

Skitts em bores em coral reefs



A reacao

$$2(CaCO_3) + Mg^{++} \underset{\text{calcitização}}{\overset{\text{dolomitização}}{\rightleftharpoons}} CaMg(CO_3) + Ca^{++}$$

depende de P, (T, Ca^{++} Mg^{++} $(CO_3)^{=}$, Na^{+}, Cl^{-} concentration
e concentração de todos os outros ions

Conservando T etc constante (o que se pode esperar em mares tropicais, ~~temp. alta e concent.~~ mais ou menos fechados e em condições iguais ± especiais) pode-se pensar que a profundidade é o unico fator para trazer a reacao → ou ←. Em uma pressão entre 1 (calcita estavel / dolomita) e 4 (dolomita estavel / calcita) atmosfera pode-se esperar equilibrio.

Assim dolomitização em pressões pequenas. Mas até agora ainda não se estudou o probl sobre o pto de vista termodinamico ou kinetico. Mesmo no campo da dolomit estavel a dolomitização pode não ocorrer devido a insuficiente velocidade de reação.

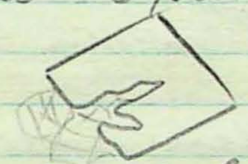
Conclusões

Parece que as evidencias sugerem de qualquer modo dolomitização (pelo menos nos casos de dolomitização original recente) é favorecida por aguas mornas, rasas porque os coral reefs são os mais outstanding examples.

O fato dos dolomitos serem em geral mais porosos nada prova sobre a origem da rocha ser por substituição. A redução de volume e formação de espaços pode ser devido a lixiviação posterior. Redução (ou aumento) de volume depende também das quantidades de materiais que entram e saem

Idiomorfismo de dolomita contra calcita simplesmente significa que ~~dolomita~~ as superfícies de tensão entre calc e dol é tal que ~~calcita~~ dolomita forma suas próprias ~~formas~~ faces em prejuízo da calcita. Mas podem perfeitas ~~formar~~ ter-se formado simultaneas!

Turner cita ~~o~~ caso de rombs de dolomita idiomorfos sendo substituídos pela calcita xenomorfica



A questão de dolomitos serem em geral ricos em Fe não significa condições redutoras ou oxidantes favorecendo formação de 1 ou outro tipo de rocha. Em calcita, Fe não substitui Ca e Mg muito pouco. Supondo agora dolomita, Fe substitue facil/ Mg.

∴ é natural que se tenha dolomitos sempre ou quase sempre mais ricos em Fe do que ~~calc~~ calcareos calcíticos. Mas isto não ~~seg~~ tem nada que ver com condições de origem

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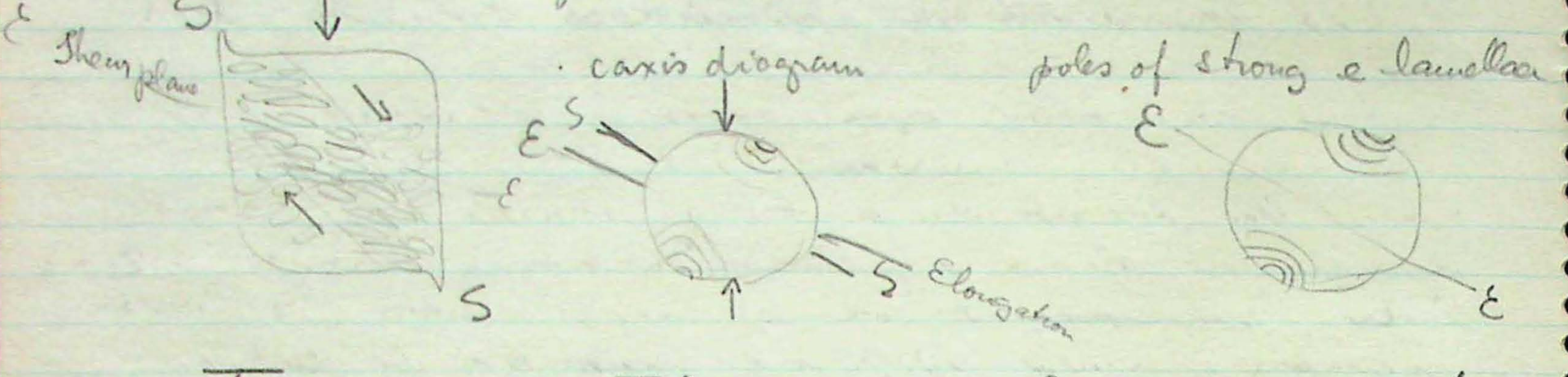
Casos em que shear develops



~~at~~ At T° of 300–400°C and 5000 at.
⊥ cylinders in compression have been shortened by 30-40%

Note that axis of compression is ∥ to the general direction of alignement of c axis in the original fabric

The specimen deforms by shear which is concentrated in a diagonal zone. Outside the sh-z the grains are considerable flattened but in sh-z they are very greatly flattened

In sh-z there is a foliation due to sub ∥ alignement of flattened grains in the plane ε-ε. This foliation approximates the ab plane of strain ellipsoide

Fabric analysis show very strong concentration of c axis ⊥ to plane εε. Also a very strong " of e-lamellae poles which coincides with the c-axis maximum

Although the c axis maximum and e-lamellae pole max. approximately coincide ~~there~~ it is obvious that c axis and e-lamella pole for the same grain cannot coincide. mas estatisticamente as lamelas mais fortes tendem a se agrupar no mesmo ponto = c axis

In all experimentally deformed fabrics the simetry of the fabric reflects the simetry of the deforming movement

4) Mechanism of strain in orienting Yule marble

The microscopic appearance of fabric of marble deformed at 20 – 150°c and the short duration of experiments, both indicate that recrystallisation cannot have been important as a mechanism of deformation. We appeal instead to direct componental movements, mainly plastic flow of grains accompanied by at least marginal fracture & by rotation

In slow deformation at 300 400°C, recryst. especially along grains margins probably plays significant part but plastic deformation and rotation of grains is probably still dominant. Metalurgists have appealed to 2 alternative hypotesis of deformation of xline aggregates

a) Non-Homogeneous deformation
It is assumed that in the 1st stages of deformation all of the plastic strain is accomplished by complete tw. of small number of grains which are so oriented the the resolved sh-stress on the tw plane and in the tw glide direction is at the maximum. Subsequent deformation is then taken up within somewhat less favorably oriented grains etc

b) Homogeneous def
This assumes that at any stage all the grains are similarly deformed
Each grain of coarse will deforme by gliding on the most ~~favorable~~ highly stressed ~~xlographic~~ glide plane within that grain.

We have 2 independent set of data in the case of marble.
1st the stress strain data and
2nd the change in preferred ~~orientation~~ in c-axis

The stress-strain data

For any T° we have a series of str-strain curves for marbles of ≠ orientations. The spread of the curves reflects ≠s in strength which depends
1) on the ≠s in orientation of grains in relation to applied stress and
2) on ≠s in strength of calcite when it deforms by tw gliding on 01Ī2 as contrasted to translation gliding on some other plane. It is assumed in 1st place ~~that~~ ~~this~~ other plane ~~that~~ ~~plane~~ is 01Ī2 the sense of movement being opposite to that of twinning

If we take ~~the~~ a sample of 150 grains which orientation has been measured in undeformed specimen we may calculate for any experiment the ~~resolved~~ sh-stress ~~on~~ each one of 3 planes e_1, e_2 e_3 of all grains in question. We can now predict how each grain will deform according to 2 hypotesis (homogenous and non-h)

The set of str-strain curves can be tested for internal consistency on the basis of each of 2 hypothesis. Griggs found a remarkable degree of consistency for the curves 20°C on the assumption of homogeneous deformation & a considerable degree of consistency for curves at 150°C. He concludes
1) That deformation is essentially homogeneous
2) That at low T calcite deforms by twinning on e or by translation on e

The orientation data are applied as follow

Assuming homogeneous def. and tw or transl. on e as before and starting with the measured orientation of c-axis of 150 grains of undeformed marble it is possible to predict how each c-axis will chang its orientation at every stage of deformation for each experiment. The orientation diagrams so constructed agree remarkably well with those actually observed in the various deformed fabrics.

High T results

The orientation diagrams for specimens similarly deformed at 20° 150° & 300° are closely similar. This would suggest that the mechanism of def is the same. However, if we had an alternative translation mechanism at high T. f. ex. on r instead of on e this would not greatly affect the ultimate orientation diagrams (because by far the greatest orientation changes in grain are due to tw not to transl.) Griggs has found no internal consistency in the groups of curves representing def at 300°. It would seem that some other mechanism than transl on e is at work. Observations on single xl very strongly suggests that now we have transl on 10$\bar{1}$1 and that the xl is only slightly more resistent on this than it its to tw on 01$\bar{1}$2.

Note that microscopic examination on single xl favors both operation 01$\bar{1}$2(e) and 10$\bar{1}$1(r) → → as translation planes at room T. The resistance to such transl is 5 or 6 times greater than to twinning.

T & Verhoogen pg 526

Rotation of rigid grains in a plastically flowing matrix

~~The~~ high degree of dimensional prefer. orientation of rigid platy or lenticular grains may result from plastic flow of enclosing matrix.
100 years ago Sorby reproduced slaty cleavage by compressing clay in which hematite flakes were embedded. The clay flowed the hematite flakes became aligned * ⊥ to compression. ~~The~~ In general (showed experimentally & mathematically) rigid plates tend to become aligned ∥ to ab plane of the strain ellipsoid as defined for plastic deformation of the enclosing material.

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214) Strain ellipsoid

Becker - introducing concept ~~to~~ in geology G S A Bull no 4 1893
D. Griggs - Am J Sci vol. 38.
replied by Leith - Am J Sci vol. 33
Billings

The concept of st. ellipsoide developed perhaps a century ago by physicists to describe & discuss elastic strain of homogeneous material without change in volume. Under some simple conditions of stress a homogeneous sphere may be strained elastically to give an ellipsoid the 3 mutually ⊥ principal diameter of which are in general of ~~any~~ unequal length. These 3 axis in order of decreasing length are termed A. B. C

It is custom to illustrate the ellipsoid by the elliptical ~~A~~ ~~C~~ section

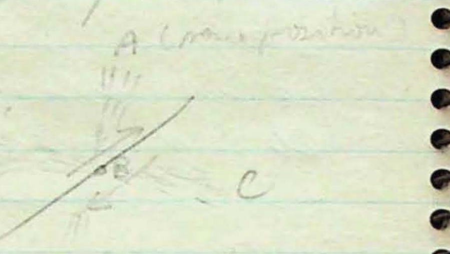
In the case of a non rotational stress the axis of the ~~ellipsoidle~~ successive ellipsoid of strain maintain a fixed position in relation to deforming forces as strain proceeds. Such is the case in the simple compression where the C axis of ellipsoide is ∥ to compr. On the other hand in the rotational strain p.y in simple shear the A & C axis rotate with reference to the stress system as the strain proceeds. Precise directions of deforming stresses cannot be deduced.

Becker 60 anos ago applied the concept of st. ellips to interpreting the strain phenomena in rocks

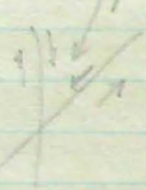
pex platy cleavage which he identified as shear structure and various kinds of shear joints
From the ellips. so constructed he attempted further to deduce the deforming forces. His approach was taken up by C.K. Leith
General deductions
1) It is commonly stated (Billings p.ex) that tension fractures form ⊥ to A axis of the strain ellipsoid. If we neglect the heterogeneous natures of most rocks we could still applie this concept only to reconstruct the ellipsoid of elastic strain immediately preceding rupture
In met. rocks which commonly show remarkably regular ac joints (Q joints de Cloos - cross joints) ⊥ to principal lineation, the lineation & xistosity are the results of long and continued plastic strain.
This is followed much later by rupture. One cannot assume the ellipsoids of elast and plastic strain have the same axis although the 2 bodies may have been simmetrically related in some way. P.ex the B axis of the first might became the A axis of the 2°.
So we cannot deduce the ellipsoid of plastic strain responsable for xistosity from the orientation of the jointing
2) It is generally stated that rupture by shear occurs on planes of high resolved sh-st. which are circular sections of the st. ellipsoid. Actually there are circular sections of high sh-st only if deformation is homogeneous and if the B-axis of ellipsoid does not alter in

length throughout strain.

If the rocks are homogeneous for argillites etc. shear fractures such as slip-joints or strain-slip cleavage no doubt represent surfaces of high shear stress in the last stage of deformation. If we know the sense of movement we can deduce the approximate position of the str. ellipsoid axis for the last stages of deformation



Experiments of engineers have shown empirically that a brittle material under simple compression tends to fail by simultaneous shear on 2 sets of fractures the acute ∠ between which is bisected by the axis of maximum compression (Hartmann law) Griggs criticizes him and Bucher who says compression bisects obtuse angle  *in ductile* (plastic) materials



The use of strain ellipsoid in geology is limited. It can never be applied to interpret schistosity (or slaty cleavage) except

1) where the schistosity were determined by tabular bodies which can be proved to have been rotated passively into their present position through plastic flow of the surrounding material

2) where originally spherical or nearly spherical bodies (pebbles or much better oolits or pisolits

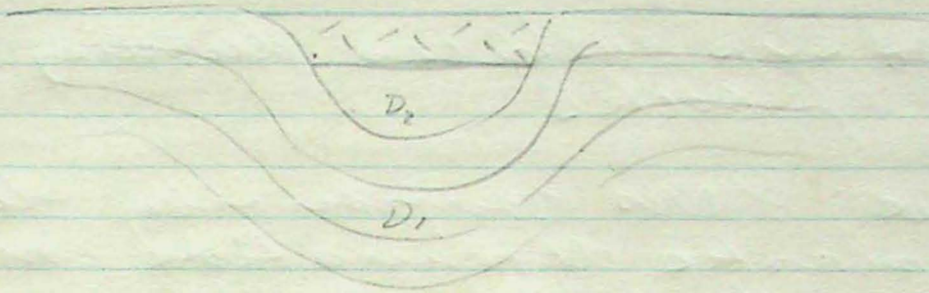
have assumed a markedly ellipsoid form and in this way have caused a xistosity to devellop in the rocks which

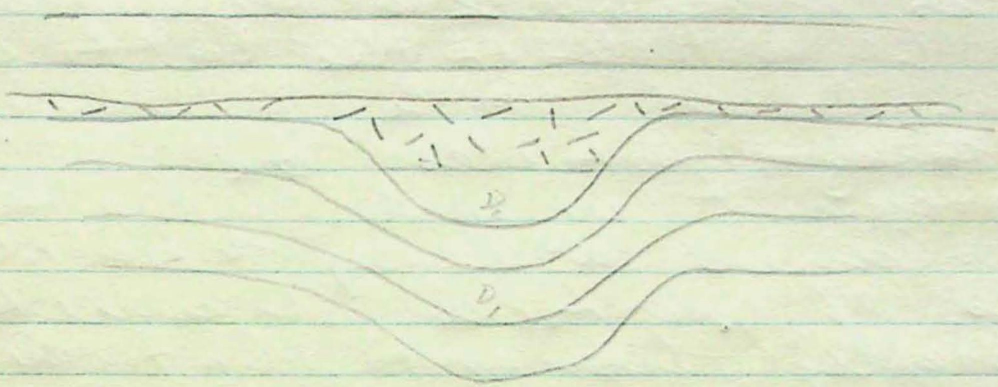
gilbert-Wilson
Geol Mag. vol 89 1952
(rather good paper)

In the case of rupture deformation leading to joint we may sometime introduce a st. ellips for a very limited field of rocks for the relative positions of shear a tension joints (Billings)

Note
A strain-ellips cannot be applied even qualitatively to an area of folded rocks The axis of folding whether by pure flexure or by shear or both, is of rapid local variation in the degree and kind of deformation.
P ex in the folded competent bed the limbs are almost undeformed and in the crest, the outside is stretched the inside is compressed
A st. ellips. can only be applied to an area of uniform or approximately uniform deformation
Again it is impossible to describe st. ellips. for a large area of heterogeneous rocks.
Finally we know that in the case xistosity we are dealing with *plastic* not ellastic strain, and we can seldom describe a strain ellipsoid

In discussing various simple kinds of deformation from the theoretical or experimental side where we draw such data as directions of applied stress and directions of plane of shear it is convenient to use the str- ellips. to relate these given directions to the calculated or experimentally observed directions of elongation and shortening in the strained mass





Dolomite
grow bigger ?: on

13 - Maio - 1953

2/Y

Turner & Verhoogen (518-523)

Development of slip surfaces during deformation of rocks

One of the probls confronting the students of plastic deformation concerns the scale on which the component particles are displaced relatively to one another. F. ex within a single crystal it is possible ~~2~~ alternatively
1) that all ~~of~~ the particles of the lattice become displaced with reference to adjoining particles or;
2) that movement is concentrated in slip-planes widely spaced in terms of particle diameter (It is generally thought that the 2) is valid

Where rock is deforming movement may be concentrated on slip-surfaces more or less plane, which are several or perhaps many particle diameters apart. These surfaces would be determined by stress conditions (tend to be planes of high shear-stress) and also by the mechanic anisotropic condition of the rock

We may illustrate the kind of movement by referring to several very simple types of deformation.

See Turner &

Basic concept:

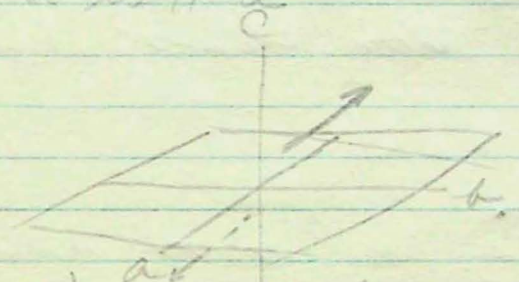
The simetry of fabric reflects the symmetry of the differential movements (not the forces which cause the movement)

Tectonites - rocks which express movements during the formation of the rock
It applies only to met. rocks!

S - Tectonites - Quebra-se ao longo de planos; lineação pouco evidente
B - Tectonites - Quebra-se em qualquer direcção // lineação evidente
R - Tectonites

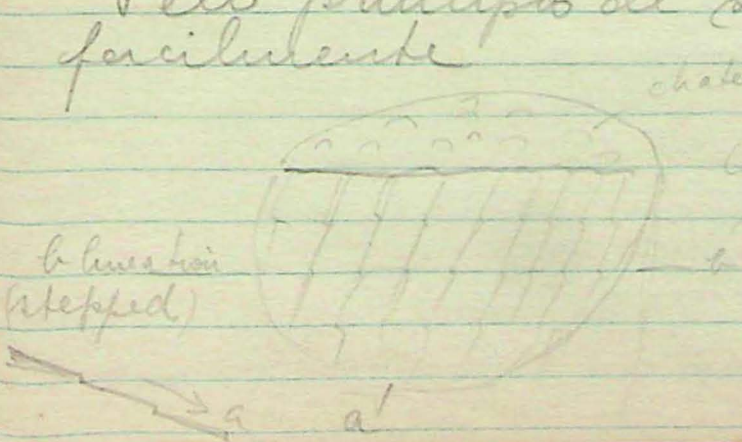
Em S - tectonite ab-plane is the S-surface
lineation is // a

b = ⊥ plane simetry em monoclinic fabrics

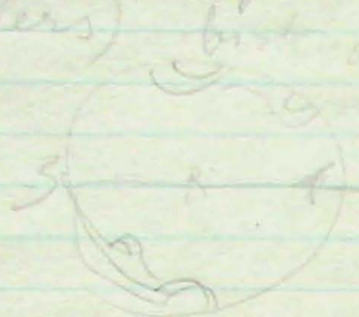


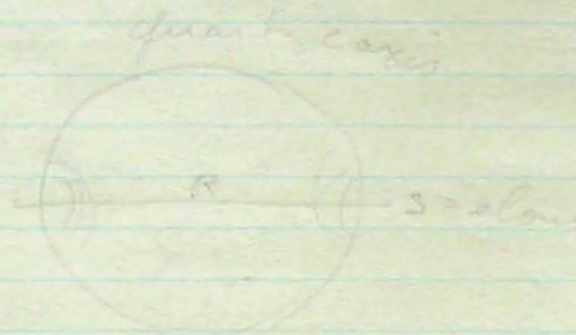
Quando se trata de mylonites e slickensides é muito difícil ou impossível fora do microscopio saber qual o movimento se deu ao longo de a ou b

Em mylon. e slick. there is always a lineation. It is usually found a b lineation or rarely only b lineation
Pelo principio de simetria pode-se decidir facilmente



Biotitas em plano de movimento em pegmatito (Saindlers)





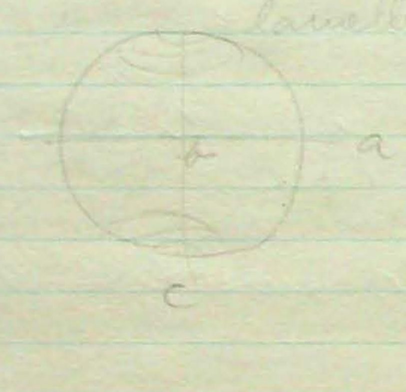
Aqui movimento é ⊥ lineacao no S = surface

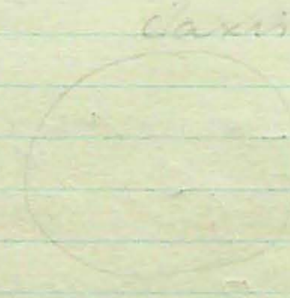
GSA Bul vol 53 (1942) Chaplain

Felkel
Em calc phyllonites dos Alpes there is S surface with

Minor folding allows identification of b axis

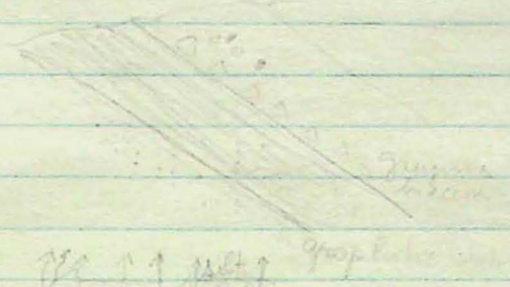
calcite (e) lamellae strongly ∥ to ab

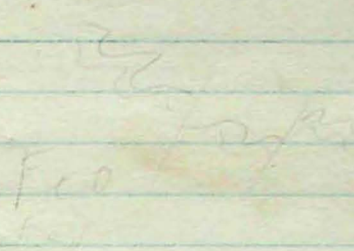


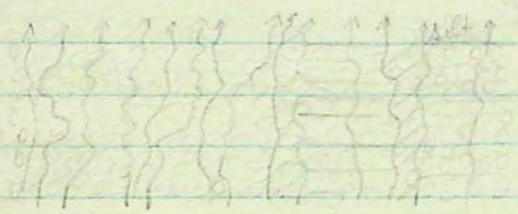


Charts
Bramlett U S G S Prof. Paper: 212
Chanmar G. S. Great Britain 1949
Tagliaferro U C Publication
Ryedemann charts G S A Bull Vol 37
White Am J Sci vol 245 pg 49

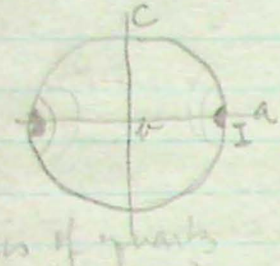
Ferro
James G S A. Bull Vol 62



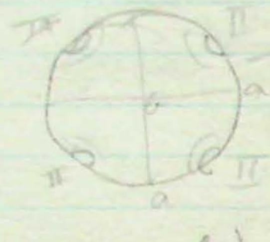




Sanders
Quartz Orientation pattern in S-tectonites are now known to be of several types
Sanders recognised 4

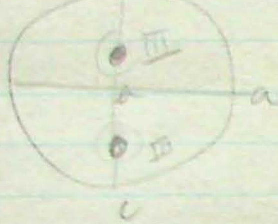


a)

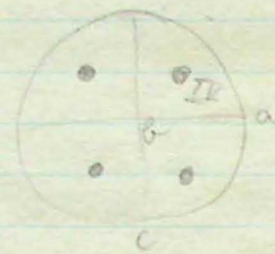


→ axis maxima at ± 45° to a c
These maxima are named maxima

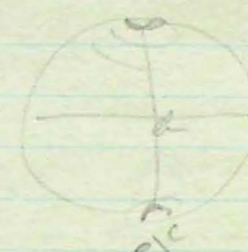
b)



c)



d)



e)

This was not recognised by Sanders But nowadays it is.

Como se formaram esses pattern nada se sabe

A number of ƒ orienting mechanisms have been suggested by ƒ people to account for these maxima. P.ex: I = glidding on a prism in a slip plane ab V = glidding on the basal plane in the " " . II = glidding on a prism in 2 (h0l) slip plane of the fabric II = glidding on a rombohedron in a slip plane ab the glide line being ⊥ to the rombohedro-prism edge.
None of these supposed to be glide planes has been shown experimentally to be effective None of the supposed slip planes in the fabric have been proved to be slip planes, except ab in a few cases. Nor is it known that xl glide planes need necessarily become aligned in slip planes of the fabric nor is the effect of rexlization accompanying defomation, taken into account

We are not justified in deducing orienting mechanisms to explain the known types of qz fabric. Nevertheless, we note that certain orienting patterns consistently tend to develop and also that they are simetrically oriented to xistosity and lineation. They contribute ~~to the~~ to our knowledge of the simetry of the fabric from which we deduce the simetry of the movements

Significance of Xistosity in S Tectonites

Turner Verhoogen p 560

Xistosity has been variously interpreted in ||

1) Xist. is ⊥ to a compressive force (Sorby, Sharpe
2) Xist is || to ab plane of the strain ellipsoide (Harker) (Leith, Mead, Van Hise etc (This is the same as 1) only where deformation is known to have resulted from simple compression)
3) Xist is || to a single set of active slip planes in a fabric (Becker

---

Lineation in met rx in general has been interpreted alternatively as

1) || to direction of movement = a lineation and it is now generally accepted for some igneous rocks where flow was presumably magmatic and not metamorphic and for slickensides and many mylonites. They lay ~~itse~~ the plane of simetr
2) Lineation || to the axis of contemporary folding = b axis of the fabric

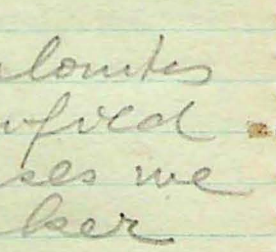
The importance of b lineation is emphasized by Sander and other alpine geologists. As b lineation becomes increasingly strong we pass from S to B tectonite class

Elongation of individual grains of of pebbles or of fossils || to lineation does not show whether we are dealing with a or b lineation. In both types of lineation such elongation is the general rule. Where a sheet of material is rolled out the direction of rolling is by definition a, the axis of rolling being by definition b. ~~[illegible]~~

Migration of ions either in plastic deformation of a grain or in recrystallization will cause the grain to change its shape, elongated or flattened, the main elongation may be in a or may be in b. On the other hand the sheet of material may become greatly elongated in a by relative movement of the grains or grain aggregates with or without elongation of these in a. The usual case is where the simultaneous elongation of grains is ~~on~~ b

In interpreting the xist. of S-tectonites we may recognise several types
1) In slickensides, mylonites & phyllonites xist. is sometimes certainly identified with shear surfaces. In other cases we may infer, in agreement with Backer ideas.

Lineation may be either a or b or both. a lies in the xistosity* in the simetry plane of the monoclinic fabric



The movement picture is monoclinic so must be the fabric.

The simetry plane of the fabric is ~~[illegible]~~ defined by girdles in qz and ~~biotite~~ mica fabrics and by rotation processes

visible swirls seen on ac surfaces and microsections.

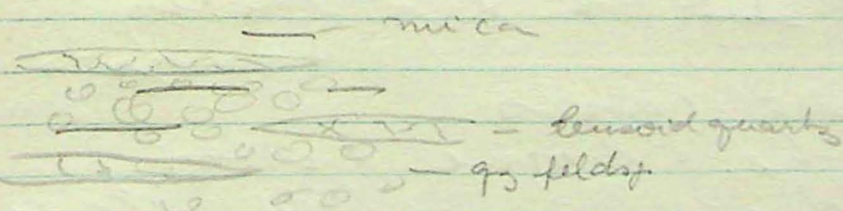
(microscopic remains of folds)

In this class of tectonites (mylonites, phyllonites etc) strong displacement is concentrated in relatively thin zones of rocks, which range from a film of material in slickensides to phyllonites movements arising hundreds of feet thick

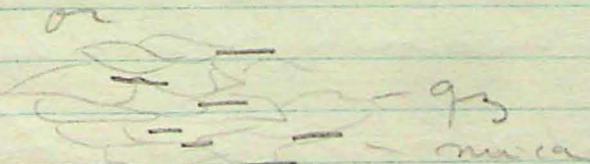
2) There are coarse-grained xists like those of Mariland which seem from the orientation patterns and from the field relation, to be blastophyllonites. Where these have one xistosity (= ab) and one lineation (= b) ⊥ simetry plane it is probably that the xistosity represent a set of slip planes and movement has been transversed to the lineation

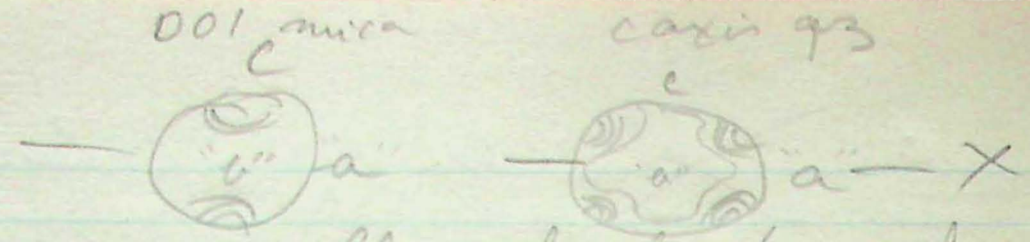
There are other S-tectonites where interpretation of xistosity is uncertain

Ex Plattungs-schistosity de Sander em "granulitos" quartzo feldspaticos



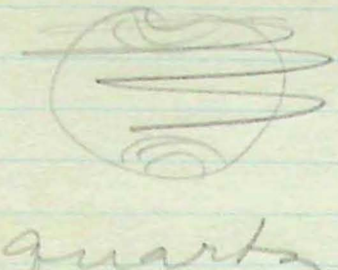
or





are usually of high met. grade
P ex ~~European~~ granulites and the quartzose members of the moine xists ~~of~~

a tipical fabric shows one strong flat xist. within which there is a faint lineation. Xistosity is derived by ‖ lenses of quartz sometimes with quartz feldspar matrix (see above) mica occurs in sharpely xlized flakes ‖ to xistosity. Little or no trace of girdle pattern about b



The qz pattern is almost orthorombic the qz axis being concentrated in 2 maxima simetrically inclined to xist. The acute ∠ between them is bissected by the normal to the lineation ("a")

There may be a slight tendency toward the formation of a girdle around the lineation

Since the simetry of the fabric aproximate the orthorombic, the movement picture is ambiguous.

Deformation might have been flattening ⊥ to xistority (plattungs-s de Sander)

However there are cases specially in the moine xists where strong folding has taken place in the nearby well lineated xists of the same series.

It is so posible that xist. is due to shear with subsequent xlization of lensoid qz and mica flakes in the plane of least resist ance afforded by the shear plane On the whole flattening seems to be more probable specially when xistosity dips steeply and strikes regularly over wide areas

Sedim Petrology

Petijohn - Heavy minerals
J SedPetro 1941 v 49

Smithson
Statistical method in sed. petr. part III Geol Mag 1939 v.76
Alteration of detrital minerals in the mesozoic of
Geol Mag 1941 v 78

Cherts

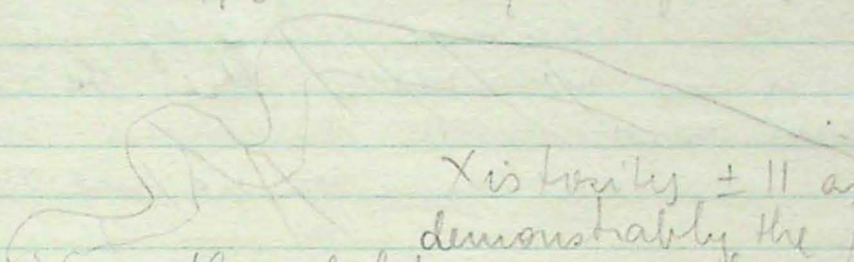
Provavel/ primario (diagenetica/ diferenciado talvez)
aguas ricas em SiO_2 1º) devido a atividade vulcanica
2º) climatic conditions em
geosinclinais causando enriquecimento local e de pequena
duração em SiO_2
Ib em bottom of ~~deep~~ seas tem-se feito hipotese de enriquecimento de SiO_2 de radiolarios etc abundandos do plancton
Pouco provavel.

Proceedings of the linnaean Soc. 1946 vol 70
Highly fossiliferous marine limestone
Barrier sandy limestone
Several bedded earthy chert
Pode-se apelar nesse caso ã deposição ritmica de chert.

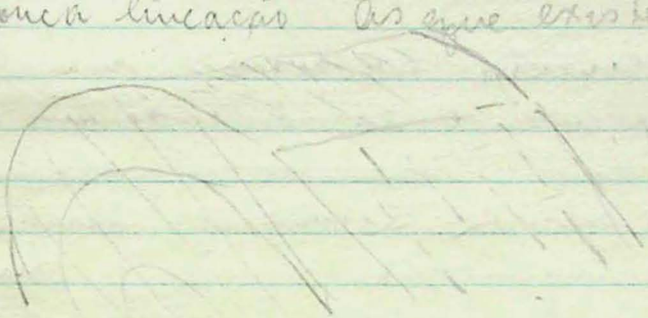
1947

Ernst Cloos – Maryland GSA bul vol 58 pg 843

Dobras (pg 855) de rochas paleozoicas para oeste



Xistosity ± ∥ axial plane of fold
demonstrably the result of shear
So the fold are mainly shear folds.
assim as rochas são antes S-tectonites, com shear-xistosity
e pouca lineação. As que existem são de 2 especies 1) ∥ fold axis
2) ⊥ " "
essa + comum



The fold axis is nearly horizontal. We conclude that the main lineation is ∥ a = direction of movement in the xistosity

Available fabric data: regarding preferred orient of quartz and calcite are not satisfactory. They do not show whether there is or not girdle around a ~~axis~~ lineation

From many measurements of deformed oolites in marble from several localities Cloos finds that there are uniformily
the lengthening of the a beeing between
1/50 to 1/100 %

He says AB plane of str. elips, aproximatly ∥ to xist.
There is some discrepance – AB plane cannot be ∥ to single set of cleavages in deformation by simple shear

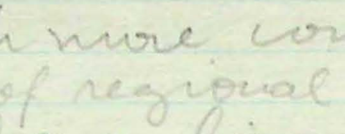
See Wilson on xistosity lineation etc Geological mag

& In this region and also others where a simple shear schistosity is ± ∥ axial pl of sh-folds the relative dip of cleavage or bedding indicates whether the beds are right way up or overturned

Where } cleavage dips more steeply than beds
~~If~~ } overturning " " " gently

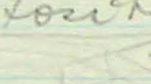
Fabric of B-tectonites

B-tectonites are much more common than s-tect. as products of regional deformation
megascopic fabric show ~~lineation b a~~
b-lineation ⊥ to a single simetry plane
simetry is strongly monoclinic
~~b~~ axis
There may be several xistosities of (h0l) type intersecting in b

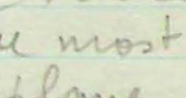


any one of these (usually the most prominent) may be selected as the ab plane

Most B-tectonites show evidences of rotation or folding around b



(veios contorcidos de quartz representam esse caso muito bem.

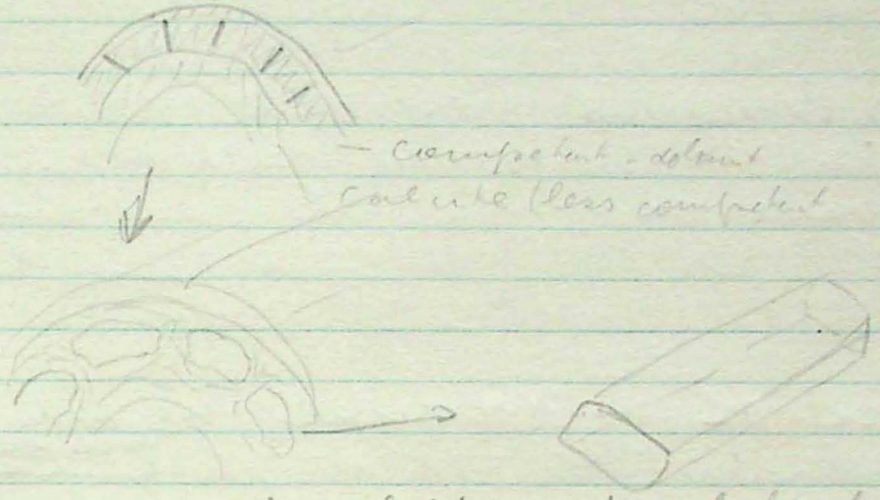


Such is the case of
The development of segregation bands of qz-feldspar followed by later folding and partial disruption of the quartzose layers, where simultaneous shearing concentrated in the micaceous layer. The axis of contorted layers of microfoldings 2)

—

The lineation is ~~also~~ marked by 3) ∥ alignement of elongated and platy ~~x~~ls and 4) development (in some cases) of boudinage & mullion structures

(see E. Cloos Trans of Am Geophys Union vol 28 no 4 1947)
Boudinage

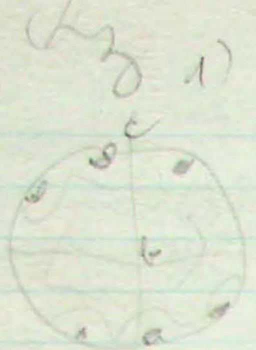


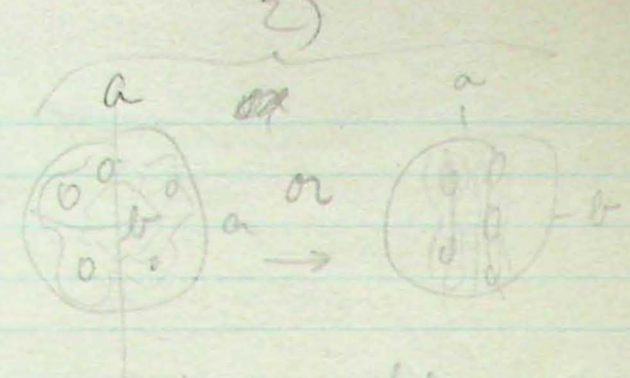
Boudinage occurs during folding of relatively competent mat like dolomite or quartzite interbedded with incompetent mat ~~such~~ as limestone or slate.
As the competent yields plasticly by shear, the competent beds fracture ∥ to fold axis. They break into elongated bodies barrel shaped in cross-section ~~but~~ with longest axis ∥ b.

Mullion in some cases is very much the same thing but it develop in quartz rich deformed rocks.
~~They ar~~ The mullions are rods elongated ∥ b
(few inches to several yards in length)

In b-tectonites there are always strong joints nearly ⊥ b axis (a little bit off ac plane)
(Cloos = Q joints)
(h0l)-joints are also common

~~Every~~ In orientation diagrams for qtz-axis, calcite axis, calcite lamellae, mica cleavages $X^{1.3}$-direction in plagiocl etc, a <u>ac</u> girdle ⊥ b almost always is well devellopped.





In qz-axis diagrams the girdle usually contains several maxima assymetrically distributed. They may lye on the boundary of the ac diagram or in some cases they lye in a small circle around b

Correlation of individual quartz maxima with imaginary slip surfaces is ~~impossible~~ quite unwarranted

Where there is several mica maxima these can same time be correlated with several s-surfaces or may ~~be~~ represent a single s-surface simply folded

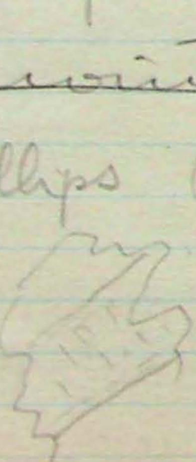
Shistosity in b tectonites are always ~~shear xxx~~ surfaces of slip in the fabric. They cannot be correlated with strain ellipsoid nor can they represent planes of flattening

When lineation is ‖ to b (as it must be in b tect) movements conected with deformation must be transverse to the lineation within the field of material examined

Moine Controversy on the Moine Xsts

Phillips (Q.J.G.S. vol 93 pg 581 - 620 1937

Escocia →



Mc Intyre geol mag vol 88 1951

" 87 1950

For R completely of view see Anderson geol mag vol 89
and Fairbairn book (G pg 188 to 189

214 Cross girdle tectonites ($B \wedge B'$ tectonites
$B \perp B'$ tectonites)

There are tectonites in which 2 girdle patterns each possibly representing a b-axis can be distinguished in the fabric and especially in or-diagr. for qz. They are designated $B \wedge B'$ tect according whether
$B \perp B'$ " there are inclined or (commonly case): mutually ⊥
(The rather common case when b and a lineation are visible in the hand-specimen are not classed in that way)
~~Ratt~~ Rocks where we see 2 lineation intersecting acute ∠ can be classed $B \wedge B'$.
(pp 554-557 no Turner book)

There are undoubted cases where a b-girdle of an early deformation is only partly destroyed by the imprinting of a 2nd b-girdle of a latter deformation (fig 9 ...)

$B \perp B'$ tectonites are so consistently developed in certain areas (especially in quartzites & granulites) that it seems scarcely logical to infer to distinct deformations. It is possible that we are dealing with 2 orienting mecanisms for one mineral. But this is not certain.
The symetry of the qz diagram is simply related to the simetry of the rest of the fabric. Probably we are dealing with a present unexplained result of a single deformation

AVA - Achsenverteilungsanalysen
(distributional analyses of axis

- A new devellopment for detail analysis of the distribution of grains of various orientations within a measured field. In the case it usually measured 1-2.000 grains every grain within a measured area must be measured. A drawing of the grain outlines takens from micrographs is prepared. All grains of similar orientation correspond to a maxima in the orientation diagram for the rock in question are colored with the same shade. Between 3 and 6 ~~such orient~~ + orientation groups each with its own color can be shown in 1 diagram. From the color diagram can be showed whether qz of 1 orientation is concentrated on one set of S surfaces or is restricted to grains of a particular shape or size. Obviously this gives information which will ultimately be valued in framing orientation rules and in deducing orientation mecanisms

Ladurner é outro que tem estudado AVA
(sucessor de Sander)

Notes on the field measurements of B-axis

1- Sander has long recognised that the B axis throughout large regions tend to conform to 1 of 2 alternative pictures; in one they are substancially horisontal (strong tectonic transport ⊥ B as in the upper level of tangencially folded regions. Alps p. ex)

In the second type the B axis ~~are~~ vertical or nearly so. Here we are dealing we squeezing movement directed from all sides ⊥ to the B-axis.

Elongation of the rock mass ∥ to B (which is also shown in some extent in the 1st case) is here the dominant elongation.

In ambiguous cases where the ∠ between the strike of xist and lineation varies and also the plunge of lineation, Sanders recognise 2 possibilities
1) Where the ∠ between the strike of xist. and lin  decreases as the the ∠ of dip of xist. increases  ; the B-axis approximates the case 1 where B axis is horizontal
2) Conversely where the ∠ between Lin and strike of xist increases when dip of xist increases we have an approximation of the case of vertical fold axis

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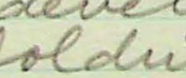
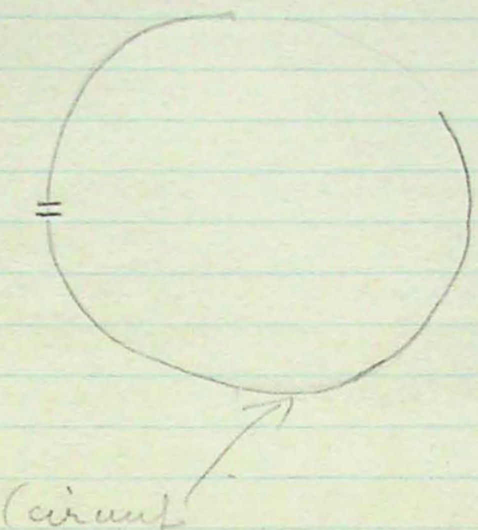
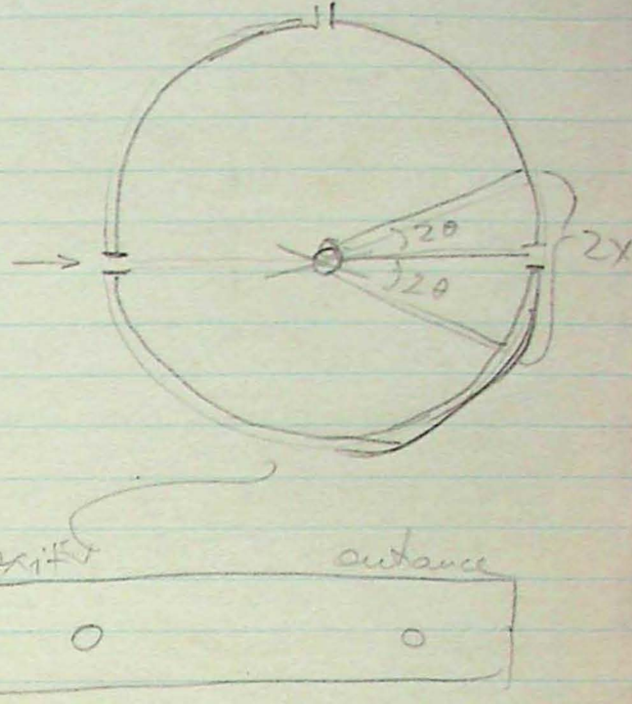
2) Not uncommonly the main metamorphism in which xistosity and the main lineation develop B_1 is followed by latter folding with axis B_2, sometimes there is development of 2nd lineation B_2. 
If the axis of the 2° folding is nearly horizontal than the ~~pitch~~ plunge of B_1 varies it increases as the dip of xistosity ~~increases~~ but the pitch of B_1  is constant





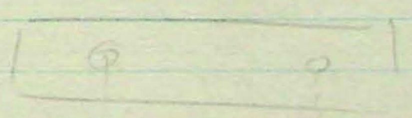
$$\frac{2\cdot\pi r}{2x} = \frac{360^\circ}{4\theta}$$

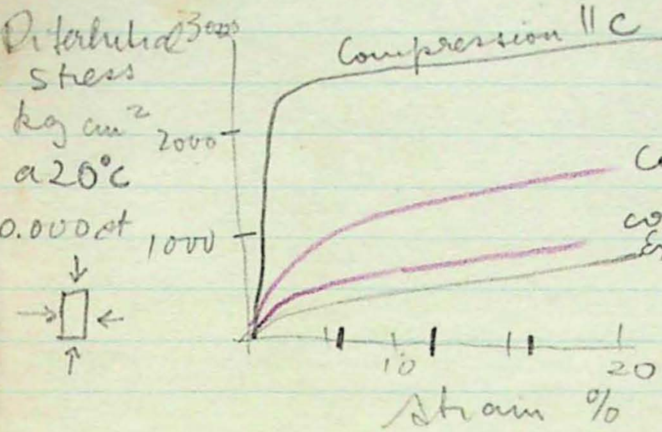
$$4\theta = \frac{2x\,366^\circ}{2\pi r}$$

$$4\theta = \kappa x \quad \text{if } \frac{360^\circ}{2\pi r} = 1$$

$$4\theta = 2x$$

Se a camara for construida de tal modo que
57. mm
Circunferencia apos processo de revelação, e secagem
é pouco ≠ de 360 (no filme). Corrigir-se por
calculo das distancias
que deve ser 180
mede-se por





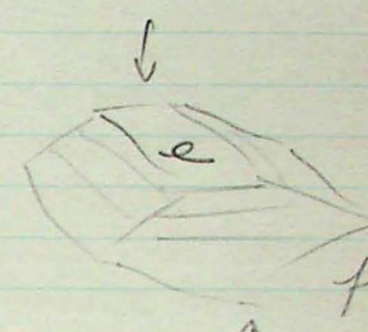
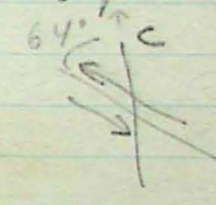


fig 1

It is clear that at 20°C calcite will deform by 2 ≠ mecanisms. 1st is the well known tw-gliding on e {01$\bar{1}$2}. Note that the sense of tw-gl is such that the upper layer of the xl are displaced toward the c-axis



Extension ∥ to c axis or compression laterally will favour such twining

The 2° mecanism is unknown

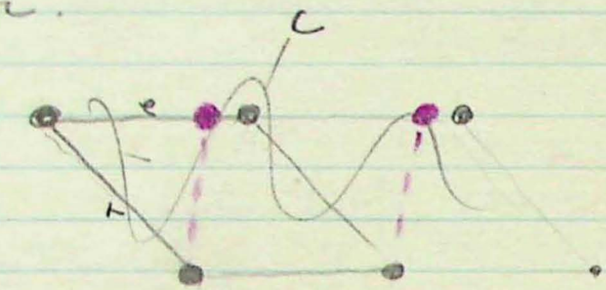
It operates for orientation wich would not allow twinning. f ex compression ∥ to c

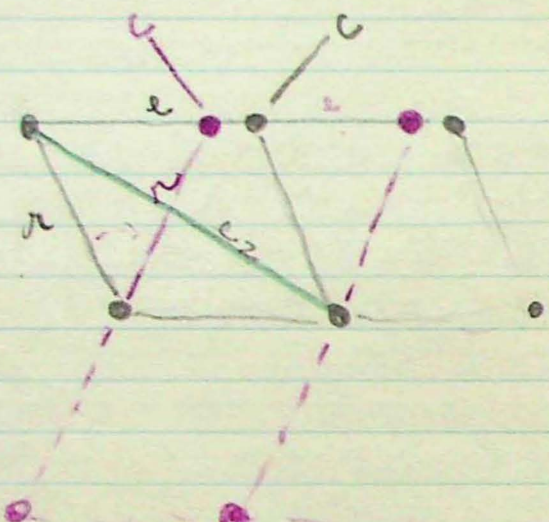
Bell (10 ago a trag) shown that a calcite xl compressed ∥ to c-axis develops external linear markings ∥ to intersection of e (fig) and cleav. faces. This were interpreted as slipe bands or slip lines, and concluded that the 2nd means of deformation is by translation gliding on e, the sense of movement being the opposite of that of tw-glid. Calcite is very much stronger in resisting this type of deformation than resisting twinning at room T°

at 150°C and above the resistance of calcite to tw-gl is much the same as at room T.

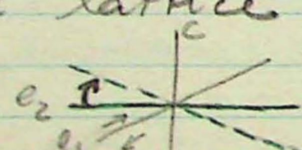
However its resistance to the 2^{nd} glide mecanism is very greatly lowered so that a 300°C calcite is almost as weak as regards this 2^{nd} mec as it is to tw.

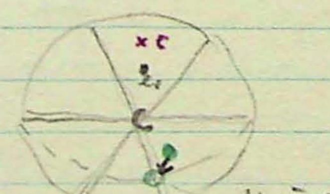
Twin no latice supondo atomos de Ca só planos e e r.





Application of the rotation principle
In tw- gliding of calcite the glide sense is such that a packet of particles originally ‖ to e_2 of the lattice would be rotated as shown

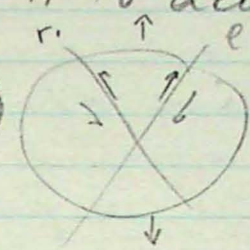




The tw gliding is of coarse under tw plane e_1

It can be shown that the lamellae e_2 should be rotated in this way so that when the x-l is completely twinned on e_1, the original

Extension at 20° ‖ to acute bisectrix of the planes e, & r,



gives an homogeneously deformed specimen lacking either e, and/or r, lamellae with no virtually external rot. It is likely that there have been simultaneous symetrical slips on e, or r. Both these direction had a high shear-stress to the assumed glide direction

Conclusions

1) Over a range 70° to 300°C calcite deforms more readily by twin gliding on e (01$\bar{1}$2)
2) For xls so oriented that tw is ~~not~~ impossible, plastic deformation at 20° is by translation on (01$\bar{1}$2) or on (01$\bar{1}$1)
3) At 300° resistance to translation on 01$\bar{1}$1 is much diminished so that this type of translation becomes important and transl. on 01$\bar{1}$2 no longer occurs. Twinning of course can occur
4) Translation either on r or e ~~and~~ leaves no visible trace on the xl apart from internal rot of early lamellae of ~~early~~ other orientation

Plastic deformation of Xline aggregates

mechanism

The term plastic def cannot be applied to rocks ~~X~~ strictly as it can do to a single xl. We use the term when the rock remains coherent throughout deformation when it maintains the strenghts and when deformation is permanent

The mechanism involved are some combination of the following

1) Strictly plastic flow of indiv. grains
(2) Rupture, granulation, rotation of grains
(3) Development of the slip surfaces within the rock fabric. Along with the r~~x~~ fails by shear

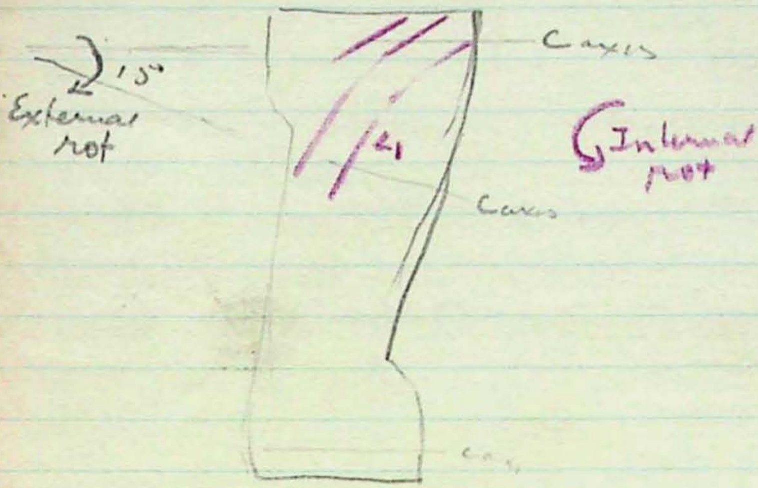
Component movements (Teilbewegungen de Sanders
4) Recrystallization; grains rendered unstable by granulation or stress are dissolved and stable grains are enlarged
The migration of ions in solution involved is called indirect componental movement by Sanders

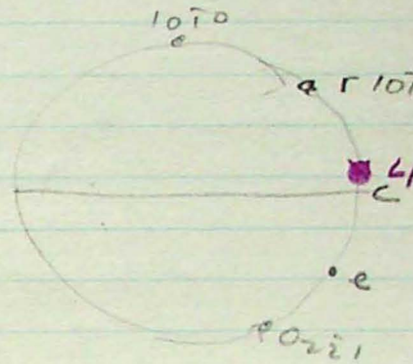
1, 2, 3 é o que se vê em milonitos
4
In metamorphic deformation there is usually time for all these process to operate.
There are 3 general cases regarding relationship in time between direct and indirect comp. mov

1 - The movem(1 2 3) takes place after crystallization (in met. rock) ~~This~~ is post crystaline movement or deformation. Products; mylonites or philonites
2 - mov & crystaly are broadly simultaneous
The mov is paracrystaline. The crystalization is parakinematic or paratectonic
3 - Cryst outlast movement, i.e the latter crystalization is post kinematic or posttectonic. The result are coarse grained xists, the xl being free of obvious strain

Note that annealing of cold worked metals is a kind of post kinematic recrystaly
It is very effective and produces a complete new fabric in which there is no trace of

lamellae is now 11 to $11\bar{2}0$ of the new lattice. Rotated lamellae of this kind have now been observed in all deformed single xls in which tw is prominant.



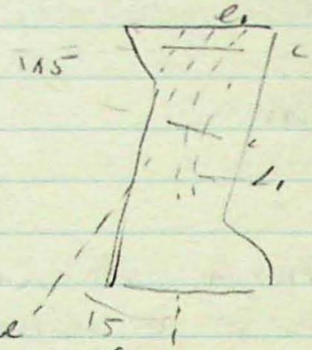


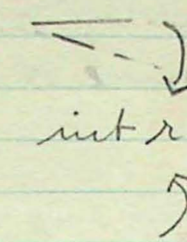
1-April-1953

now consider the case of a xl stretched in such a way that tw is impossible

Ext ext ⊥ C axis 300°

a 15° rotation of c-axis demonstrate clockwise external rotation





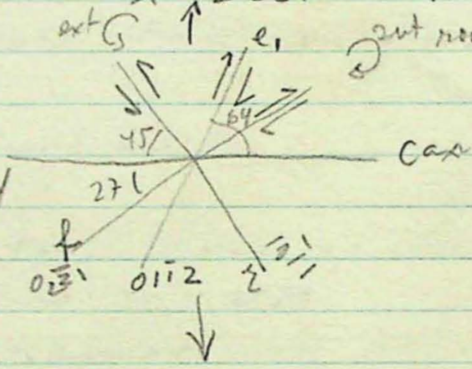
Few early formed e_1 lamellae have been internally rotated through 30° ~~around~~ in referance to c axis to give L_1. The divergence between e_1 e L_1 is actually 15° since it represents the int − ext rotation = 0

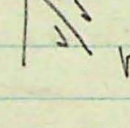
This applies only to extention ⊥ to c axis

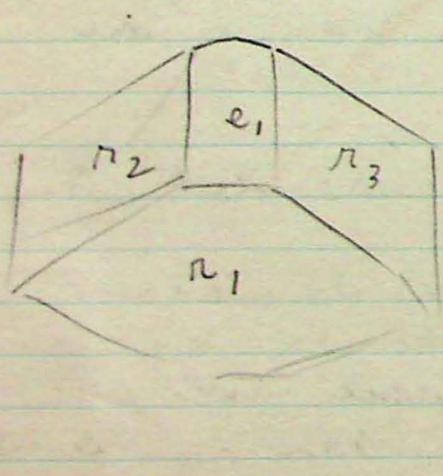
Slip on either e_1 or f_1 would cause clockwise int rot. Slip on r would cause anti-clockw int rot.

We observe anticlock rot and conclude then the mechanism of gliding is by probabley translation on r (10$\bar{1}$1) in this sence

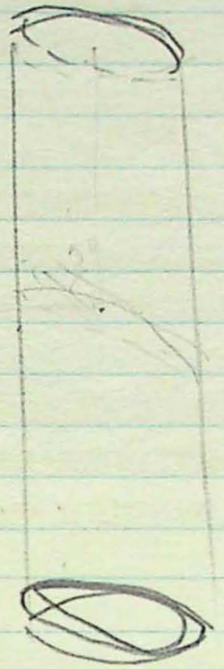
~~Probably because~~ slip in e_1 and f_1 is an impossible mechanism.







See Fuchs (neues Jahrb)



450
450
45

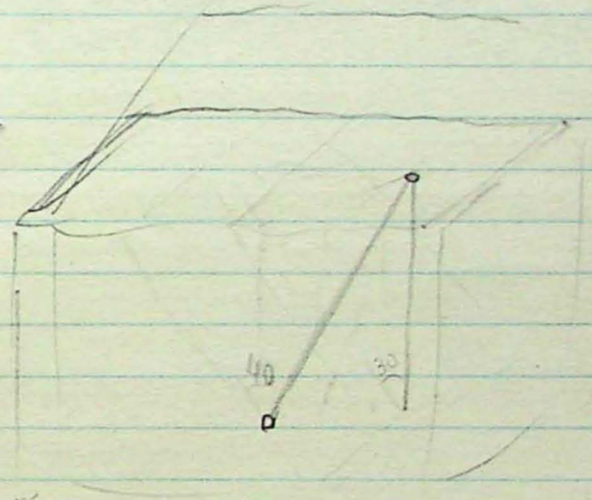
900
395
505

13.000
100
160

42
324
200
500

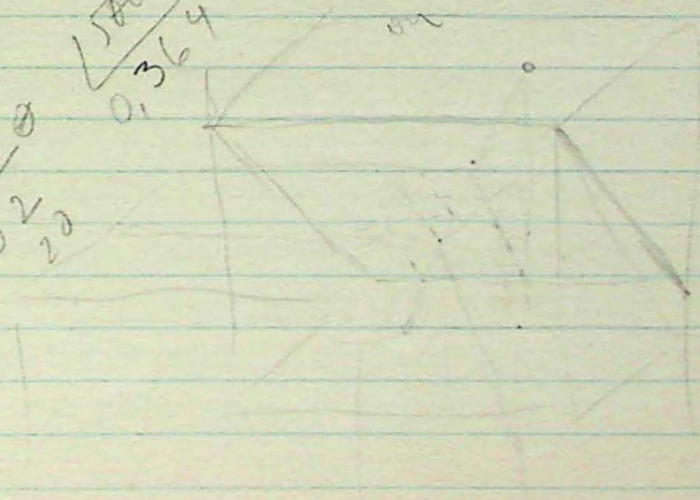
320
18
500

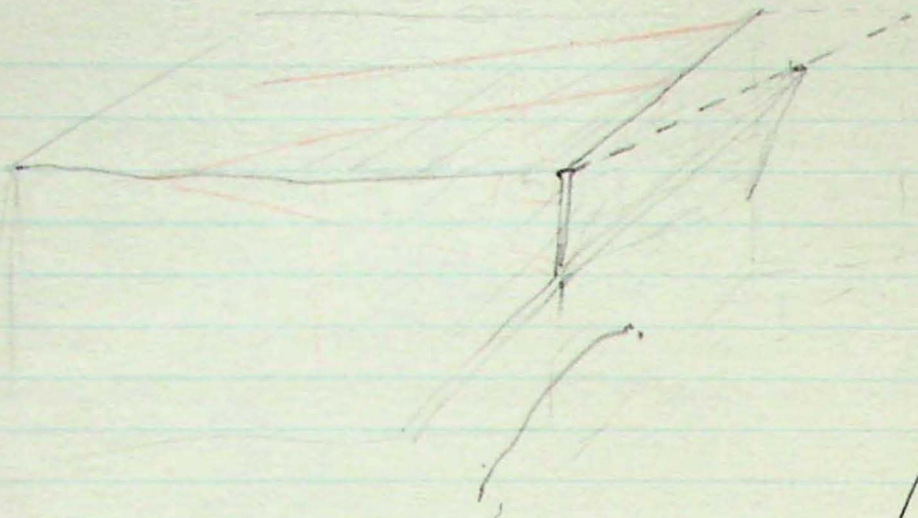
80



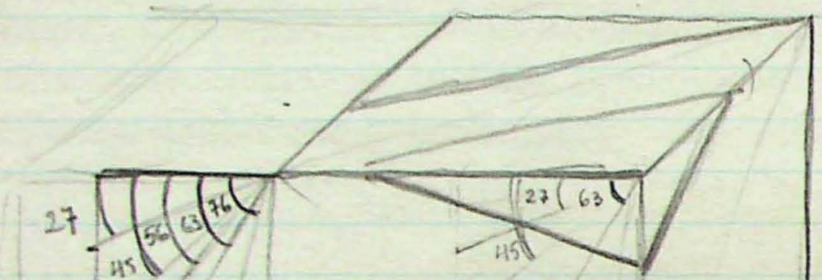
500
364
01

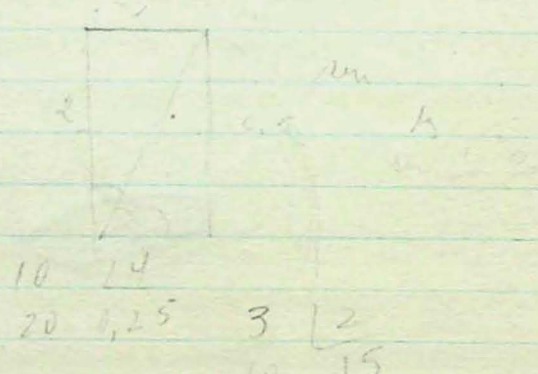
1820
32
20



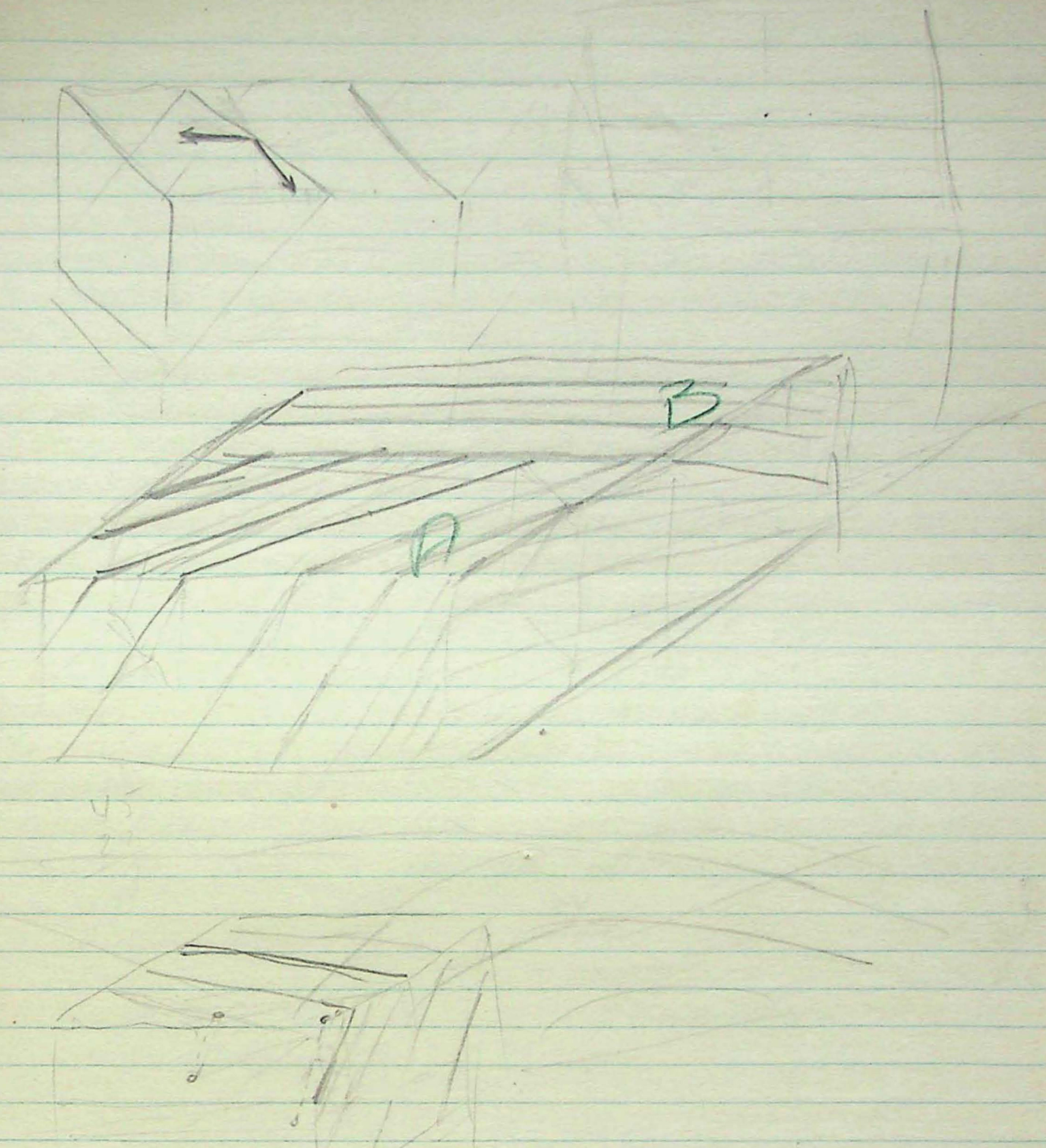


Qual a direção e sentido de mergulho de uma rocha que em secção S 36° W faz pitch de 20° p o Sul e cujo mergulho verdadeiro é 40°





Construção de blocos diagramas com o auxílio da projeção


B
A

É claro que não se falará para um negro que ele é sempre negro. Mas porque não se poderia comentar em família? Entre amigos?

Tenho para mim que o conceito de preconceito está completa/ desvirtuado. A isso que a Lila e eu sentimos você chamam preconceito. Eu acredito que você e muita gente mais, já formou um preconceito de preconceito. Sejamos mais claros; o tabú do preconceito.

No entanto você pode acreditar que os negros são em geral para mim e Lila, extremamente simpaticos. Um dos meus bons amigos aqui na California é negro. Sinto sinceramente que eles carregam aquele handicap que mencionei contra si por outro lado possuem valores de raça positivos e reais; genio para musica e dansa, força muscular e principalmente, alegria e modestia. E por isso tudo eu os admiro muito mais que aos judeus por exemplo que embora igualmente perseguidos representam o antitese do negro, possuindo virtudes intelectuais acima da normal mas sendo quase invariavelmente exibicionistas, imodestos e antipaticos (no meu modo de ver)

Você diria que tenho preconceitos mas a isso eu chamaria ser sincero e ver as coisas como elas são ou parecem ser. Nem tudo é ideal neste mundo meu caro. Assim como entre amigos, criticamos pessoas também em família podemos criticar nações e raças. Porque não?

Você não o para o ultimo caso porque é amarrado e cego por convicções. Mas intimamente embora não o confesse já terá mil vezes julgado raças. Quanto a povos e nações, bem, não é preciso lembrar que em sua ultima carta você classificou os uruguaios de [illegible] simpatica. Sempre os considerei gente muito mais evoluida interessante e simpatica que os argentinos por exemplo. Mas respeito sua opinião e não o recrimino por isso. E também não diria que você formou um preconceito contra os uruguaios...

Bem vamos ~~parar com~~ terminar o assunto, Você ~~já deve estar com raiva com essa sentença~~ porque estou vendo uma veia saltada na sua testa e a infalível frase prestes a sair em falsete (aquela que começa assim; você vai me perdoar mas...) sinal que o moleque cafuzo está bravinho mesmo. Quanto aos ~~[illegible]~~ feios palavrões, retribuo agradecido.

~~Cartíssimo~~ Caro Erasmo

Saluti e figli maschi para você e Aparecida.

Demorei um tanto para ~~escrever~~ responder porque gostaria de lhe escrever uma carta mais longa desta vez. Nunca encontrava tempo para isso. As aulas de manhã e a tarde e visitas, televisão cansaço e preguiça à noite ~~me impediam~~ me keepavam completamente out of desk & pen. Hoje terminaram as aulas ~~[illegible]~~. Finalmente tenho tempo de usar a maquina que o Departamento gentilmente ~~[illegible]~~ pos a nossa disposição.

Grato pela carta. Realmente sua 1ª ~~carta~~ missiva era ansiosamente esperada. O cavalheiro é um rapaz com quem se pode conversar num nível elevado, de quem sempre se espera algum dito espirituoso, e ~~algum~~ deliciosa ~~saída~~ comentario a la G.B.S. Infelismente o intercambio epistolar não nos permite apreciar aqueles suaves pigarrinhos e ~~[illegible]~~ a caracteristica e a sedutora ~~[illegible]~~ e cadenciado balanço de corpo sobre um e outro pé e os gestos e os encantadores palavrões que tão bem o caracterizam. Alem do mais caro Garciata, você sabe por experiencia propria que a gente no extrangeiro sente falta de cartas nem que seja de um ___ como você.

Agradecido pelos comentarios favoraveis a minha pessoa. Não os mereço. É verdade que voltarei dessa terra com mais conhecimentos tecnicos no meu ramo de eletricidade, e, espero, sem este irritante snobismo que ~~caracterizam~~ me a gente sente em tantos dos ~~que~~ nossos conhecidos que por aqui estiveram. É certo tambem que os States não me impressionaram tanto como talves se esperasse. Acredito que seja por demais realista (~~demais~~ não me refiro ao realismo do Maurras) e que as belezas e virtudes do extrangeiro não me embasbaquem como deviam.

(*) ___ ~~Deixar~~ Como sei que você provavelmente mostrará esta carta a Aparecida, deixo ~~inteiramente~~ de escrever a "palavrinha" ~~que imaginei~~ ao seu ~~arbitrio~~. Deixo ao seu criterio a escrevinhação da dita cuja. Escreva "genio" por exemplo. É mentira, mas é gozado!

De um modo geral creio que já lhe relatei as minhas impressões sobre o tio Sam, sua gente, sua mentalidade e seu modo de ser. Em síntese minha opinião é essa; gente geralmente boníssima individualmente, com graves defeitos do ponto de vista coletivo. mas Você tem que concordar que politicamente e socialmente ~~eles~~ ~~eu~~ apesar de certos pontos negros, eles estão ~~muito~~ ainda assim, furos acima de nós. Por outro lado ~~mas eu tenho que~~ devo confessar que "morro" pela nossa gente e a nossa baguunça. Quando aqui chega o Estadão é uma hora inteira que tiro para lê-lo de cabo a rabo o calhamaço ~~reacionario~~ desde as idiotices dos Mesquita até os anuncios de casas para alugar e teatro da Dercy Gonçalves.

Quanto às belezas naturais, ~~convenhamos~~ convencionemos desde já; os Estados Unidos é um país feio até onde pode ser com ~~algumas~~ raras excessões; ~~os~~ alguns dos chamados parques Nacionais. P. ex. O Yosemite que conheço mais de perto, ~~por exemplo~~, excede em beleza natural a tudo quanto eu imaginava. ~~É uma~~ A gente postada no fundo dos seus vales ou no alto de seus domos se sente até deprimida, achatada, arrepiada, ~~de~~ deslumbrada e ~~tanta beleza~~ pequeniníssima deante da medonha beleza dos abismos, da indescritível alvura da neve e da ferocidade com que as aguas se atiram sobre as rochas ~~as~~ ~~rochas~~ ~~se~~ depois de despencarem 800 mts da boca dos majestosos ~~de~~ vales suspensos ~~ao longo de~~ ~~800 metros~~ acima. (ponto final para a secção dedicada a Euclides da Cunha) ~~De~~ um modo geral porem, a paisagem brasileira bate longe a daqui. Não ~~vou~~ quero repetir aqui o que você já sabe e já observou mas a verdade é que as praias por aqui são incrivelmente sujas e sem graças e ~~metad~~ 1/2 do país é formado por planicies de uma monotonia a toda a prova. Na outra metade dominam as ~~morros~~ colinas peladas cortadas de asfalto ~~e~~ vestidos de cidades, chaminés e torres de petroleo envoltos em fumaça de carvão e salpicados de avisos, setas, anuncios, cartazes

e latas vazias de conserva
vazias de conserva, garrafas quebradas e papel.
Do ponto de vista do turista, para mim, mil vezes preferível às planícies do Brasil em que a serra arada daqui é substituída pela floresta virgem da Amazonia
Mil vezes preferível ou a caatinga do nordeste e onde ainda se sente uma sensação de perigo e aventura
mil vezes preferível as serras de Minas e Estado do Rio, e milhões de vezes preferível o nosso litoral onde canta o sabiá e cospe de banda o caiçara. Fim da secção dedicada a Gonçalves Dias e Monteiro Lobato
Acredito que você não tenha criticas a fazer quanto ao que foi dito. Mas agora, o que você lerá agora vai doer, a você, que talvês não esperasse mais de mim essas revelações e a mim porque tenho que as fazer. Penso que você já me considerava um cara "evoluido" (isso seu modo de pensar) e sem preconceitos mas tenho que lhe dizer que minhas ideias não mudaram absolutamente nada desde que vim para cá. Sou democrata, do tipo ocidental, vejo graves defeitos no communismo, sou antinazista até a raiz dos cabelos mas me reservo o direito de julgar como bem quizer pessoas, nações ou povos. E baseado no pouco talvês que eu sei através livros, conversas, jornais, vida universitaria e observação pessoal, formei meu conceito sobre certos povos e raças. Isso tudo vem a baila porque acho que você cometeu uma pequena injustiça com a Lila e eu quero defende-la. Se ela disse para a dna Ziquinha, que negro é sempre negro em qualquer logar do mundo porque viu a algazarra que eles fazem pelas ruas daqui, não teria ela um pouco de razão? Vamos analizar o caso;
O raça preta é ou não inferior a raça branca? Evidentemente aqui cabe uma outra pergunta Em que sentido? Eu responderia; é inferior se você pesar as qualidades intellectuais de ambas as raças. O negro

é superior se você considera suas qualidades físicas. ~~Ambos os argumentos devem ser considerados estatisticamente.~~ ~~Você poderia argumentar~~ O branco é mais evoluído em tudo que diz respeito às atividades do espírito ou se quiser, na linguagem anatomica, do cerebro. O preto é mais evoluído e mais apto a realizar os trabalhos que envolvem esforço físico. Assim poderíamos esperar melhores cientistas, poetas, escritores políticos etc entre os brancos e melhores ~~cantores~~, ~~saltadores~~, ~~corredores~~, atletas entre os negros. Estes ainda seriam dotados de melhor audição, visão, olfato e voz (cantores) E não é realmente isso que acontece? É claro que se deve argumentar estatisticamente. Existirá sempre uma pequena porcentagem em cada grupo, que foge à media geral e ~~vão para cima ou~~ para baixo se mostram ~~so~~ com qualidades ~~acima~~ de nivel superior ou inferior à media. Não é preciso que você me lembre que existe uma porção de (você não diria inúmeros) ~~de~~ negros bons (cientistas, também políticos e ~~poetas~~ escritores. Assim como existem alguns Ralph Bunches e Whites ~~e outros~~ capazes de superar brancos ~~em suas~~ nas atividades ~~prediletas~~, ~~assim também~~ características destes, assim também haverá Rocky Marcianos e Bing Crosbys capazes de se distinguir em ~~campo~~ competições contra negros. a regra aceita excessões é porque a que mencionei

Você argumentará que aos negros não são dadas as mesmas oportunidades que se dão aos negros. De acordo. Realmente essa discriminação ~~realmente~~ se observa aqui, ~~Parece-me que isso se dá~~ aqui nos EEUU e talvez em menor escala no Brasil. Mas o negro encontra a mesma resistencia ao ingressar numa escola, numa fabrica ou num clube esportivo. No entanto é capaz de vencer as barreiras no campo atletico (~~No entanto~~, Por outro lado o negro não é apto bastante ~~não é bastante capaz~~ para se distinguir normalmente nas atividades do espírito. Diga-se de passagem que

e levando em consideração a porcentagem de população negra aqui nos U.S.A., ~~são em numero~~ é surpreendente) elevado o numero de negros ~~os que o~~ fazem com sucesso.

que aqui na California pelo menos, eles frequentam escolas com os brancos e possuem as mesmas facilidades que estes embora segregados,) nos Estados do Sul, embora (estupidamente segregados ~~os negros possuem nos Estados Sulinos escolas secun-~~ eles possuem sua proprias ~~darias~~ escolas secundarias e ~~[illegible]~~ universidades ~~Evidentemente há uma errada~~ estupida segregação ~~[illegible] proprocasse~~ a vontade. Aqui na California 100% dos negros são alfabetisados, uma ~~grande~~ regular porcentagem cursa~~m~~ os high schools e muito poucos entram na universidade. Porque? Seria ~~falta de dinheiro~~ por falta de ~~[illegible]~~ base economica? Acredito que não. E' tão grande o numero de negros ~~aqui~~ que possuem automovel (caracteristica/ luxuosos) que eu me inclino a supor que eles não prosseguem nos estudos porque esmorecem e se sentem incapazes. Mas não discutem joias de clubes e preço de automovel.

Só vejo nisso tudo uma explicação; o negro é das raças humanas a menos evoluida intelectualmente E é natural que isso aconteça, as muitas ou centenas de ~~os~~ milhares (ou milhões?) de anos em ~~que passaram nas flor vivera~~ de vida de selvas ~~tem~~ não de ~~que~~ ter influido de algum modo, aperfeiçoando as qualidades fisicas e amortecendo ou retardando as qualidades exigidas para o que hoje chamamos de "vida civilizada"

Muitos dos habitos da vida ~~antiga~~ de jungle eles ainda conservam e o branco terá que presenciar a esses atavismos por seculos ainda. Quando eles se reunem em grupos são geralmente tão escandalosos ~~em suas fazem lembrar os bandos~~ (para nós, brancos) em suas expansões que fazem lembrar os bandos ~~de de negros das tribos~~ africanos ~~em suas canções guerreiras. durante~~ as ~~reuniões~~ em canções guerreiras.

Esse comportamento, contrario ao do branco ~~diferente do~~ do branco em muitos aspectos não pode deixar de impressionar a estes. Daí essa frase preto é sempre preto. No modo de pensar de outras raças; branco tambem será sempre branco. ~~Ele come carne de porco nos paises Oriente proximo~~, não respeita animais na India, teima em andar vestido na Africa, e Confucio para ele nunca passou de um excelente filosofo.

~~I had noticed this same problem after reading the paper~~

The author is not ~~very~~ clear enough ~~in his paper~~ when ~~he~~ deals with this subject in his paper. However during the general discussion which followed the presentation of the papers he ~~stated~~ explained in a better way. ~~[illegible]~~

In this regard, one of the scientists attending to the meeting, ~~said~~: W. A. C. Newman said:

The Carpenter's view of the problem is not easily understandable for me. That is the reason why I ~~fully~~ thoroughly transcribed some critical topics of ~~this~~ the text, leaving it up to your judgement.

It seems to me that Newman's suggestions (top of the preceding page) are much ~~more~~ simpler and objective.

of distinguishing between a deposit of silver formed at a high temperature, and one deposited at a low temperature and then thermally metamorphosed by a rise of temp due to some natural causes. It seems to the authors that as a rule there would not be any essential difference between the two types. The reason why they suggested in the paper that the specimen from Chile was formed at a low temp. and then heated, was that the structure, though recrystallized, was not homogeneous. It contained vague zonal markings, which represented the original structure of the metal. These markings were of a type that was observed in some partly-annealed specimens of secondary native copper. This suggested to the authors, admittedly only by analogy, that the silver from Chile had been formed at a low temp and then heated. Not one of the specimens of native silver that they had reason to believe primary (i.e. of high-temp. origin) contained any trace of zonal markings, or of any structure other than its homogeneous recrystallized structure. The authors do not wish to suggest that Ag deposited at a moderately high temp could not contain some trace of a zonal structure, nor that Ag deposited at a low temp and then metamorphosed thermally must always contain some trace of its original structure - if it were heated to a sufficiently high temp. it would not. They merely suggest that in certain cases the presence or absence of zonal markings might serve to distinguish between the two types of deposit. Another possible distinction is that thermal metamorphism might - in some cases be localised. Where only a proportion of the samples from a deposit have a homogen struct. thermal met. is indicated. On the other hand, where samples from all parts of the deposit have a recryst. str. the evidence suggests that the metal has been formed at a high temp.

If the heat treatments had been continued for a year instead of a week, the silver would no doubt have begun to recrystallize at a slightly lower temperature than 220°c. To make the silver recrystallize at, say, 190°c., however, might have taken centuries. Assuming, therefore, that the temperature of the deposit would not remain constant for centuries, it may be deduced that the silver from Cobalt, which had a recrystallized structure, was probably formed above 200°c. Now the rate of recrystallization and the rate at which the structure becomes homogeneous increase considerably at temps above the recrystallization temperature, and the time factor becomes more important. As prof. Merrett pointed out, the specimens of silver from Montana did not become homogeneous till it was heated about 100°c. above its recrystallization temp. In the heat-treatments of the specimens from Cobalt, however, the structure became homogeneous at a temp only about 60°c. above the recrystallization temp. though the treatments lasted only a week. If the experiments had been continued for a number of months, the structure would have become homogeneous at a distinctly lower temperature, and if they had been continued for some years the reactions might have been completed at a temp not much above 220°C. The authors consider, therefore, that when a deposit of native silver has a homogeneous recrystallized structure, it has been formed at a temperature above the highest temp at which the metal fails to recrystallize in reasonably prolonged heat-treatment experiments but not necessarily much above that temp. / Prof Merret also asked whether there was any method

~~For reasons~~ The recrystallized structure of the silver was believed to have been formed at temperatures of between 200 and 250°C

Viz W. A. C. Newman

"The mecanism of the deposition from hot solutions has not been entered into by the authors except to suggest that the metal is formed in the completely recrystallized state (in the appropriate range of temp.). It is difficult to understand however, how the metal can be deposited in masses exhibiting uniform crystallization on polished surfaces, without postulating some simultaneous or intermediate process. Two tentative explanations may be advanced

1- The silver bearing solutions in order to exist at temperatures above 200°C are in all probability, under pressure, so that the metal at the actual moment of deposition is strained, and the conditions may be favourable to the regular crystalline formation

2- If the silver is deposited in a pulverulent form the subsequent application of pressure in regions the temperatures of which are above the recrystallization temperature would probably result in densification and crystal formation

Anyway one of the authors, H. C. H. Carpenter believes that the temperature of recrystallization is directly connected with the temperature of formation of the mineral. The following is an extract of Carpenter speech during the ~~discuss~~ discussion of this paper.

"Recrystallization and attainment of homogeneity are reactions that depend on time as well as on temp. In the authors' heat treatment which lasted 7 days most specimens of native silver began to recrystallize at about 220°C. The rate at which the recrystallization takes place, and the rate at which the metal becomes homogeneous, decrease enormously at temperatures slightly below the recrystallization temperature

As to the Mn content of natural japanese wollastonite, three specimens ~~of~~ from different localities were examined by means of colorimetry, and it was ascertained that they contain about 0.04-0.03% of Mn

~~One of the samples of synthetized luminescent $CaSiO_3$, one which contained 0.06% Mn, exhibited the cat just identical cathodo-luminescence spectrum with that given by the natural wollastonites.~~ as expected, cathodo luminescence spectrum

One of the samples of synthetized luminescent $CaSiO_3$, ~~ex~~exactly one which contained that approximate amount of Mn, i.e 0.06%, exhibited as ~~ex~~ expected, cathodo-luminescence spectrum just identical with that given by the natural wollastonites so, it is thought by the authors that the intense lemon-yellow C-luminescence of wollastonite is due to presence of Mn.

II <u>Pectolite</u> and Na-glass

~~H~~ Natural pectolite $HNaCa_2(SiO_3)_3$ from Hokkaido Japan fluoresces markedly. (The chemical composition of wollastonite is similar to that of pectolite except for the presence of water and Na) Its cathodo-luminescence spectrum was examined. It consists of broad bands extending from 500 mμ to 660 mμ with a crest at about 580mμ. Thus, it is similar to that of wollastonite, but there is the appearance of D-lines, probably due to the presence of Na as one of the main constituents of the mineral. By a prolonged cathode-ray bombardment, the colour of pectolite turns to violet which the authors thought to be connected in some way ~~to~~ with the violet coloration produced in certain kinds of ordinary Na-glass by the action of X-rays, ultra-violet rays etc. The cathodo-luminescence spectrum ~~of glass show~~ soda-glass (considered to be solid solution of Ca, Na silicate) shows a diffuse broad band in the region from 510 mμ to 670 mμ accompanied by distinct D-lines. The intensity maximum lies at 645 mμ

As a whole, both the glass and pectolite give almost the same luminescence band, harmonizing with their close resemblance in chemical composition

The content of Mn in the pectolite was determined to be 0.02% an amount too small for yielding any perceptible yellow cathod luminescence (as proved in the former experiments with wollastonite). The authors say that, provided the content of Mn is comparatively low, the presence of alkali metals in calcium silicate will easily give rise to yellow luminescence under excitation by cathode rays.

in natural wollastonite, sinthetic calcium silicate was prepared in the presence of one of fourteen different metallic salts, including the probable impurities usually contained in ordinary wollastonite. The calcined, washed and dried products were then subjected to cathode-ray bombardment. ~~The~~ luminescence of Calcium silicate containing one of the following metals: Mg, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ag, Cd Tl, Pb an Th was recorded. Except for the product containing Mn which exhibited orange or yellow luminescence any one of the other salts always exhibited a bluish white luminescence. A sample of pure $CaSiO_3$ was examined in the same way and gave a broad blue band full length at the beginning of bombardment and a less conspicuous yellow band (dotted line) after prolonged bombardment. The compared results are shown in ~~table~~ fig 1. The curve for $CaSiO_3 + Zn$ exemplifies the mentioned ~~bluish~~ white luminescence obtained using any of the mentioned ~~other~~ metals as impurities ~~impurity excepting Mn, which case is shown in curve (3)~~

Only the manganese bearing preparation (curve (3) gives an intense yellow luminescent band, similar to the lemon yellow cathode luminescence given by the natural wollastonite

a further study of luminescent artificial calcium silicate containing Mn was made. The samples were prepared in the same way as described above, the calcination temperatures varying from 600°C to 1000°C and amount of Mn added ranging between 0.009 mg and 292 mg per 1g of the mixture of calcium silicate and flux. The author gives a table of results showing quantity of manganese added, calcination temp. and colour of cathodo-luminescence. ~~the~~

In short, the results show that the cathodo-luminescence increases with the increase of calcination temp and increase of amount of manganese present (an optimum concentration or a "poisoning" upper limit was not given. So, I believe that the ~~range~~ the largest amount of Mn used is still ~~beyond~~ bellow the optimum ~~range~~ limit.)

105-M45

$2V(-) = \pm 40-60°$ $r > v$ very strong

Luminescence

1) Iwase Lofscap from North Burgers Canada
Sci. Papers Inst. Phys. Chem. Research 1937
vol 33 pp 299-304

2) Iimori & Iwase Sci Papers Inst. Phys. Chem
Research Tokyo 1938 vol 34 pp 372-376

3) " " the cathode luminescence
of luminescent calcium silicate Sci
Papers Inst Chem Research Tokyo 1938
vol 34 pp 173-181

4) Derìbérée Ann (Bull) Soc. Geol. Belgique
1938 vol 61 pp 104-108

On LUMINESCENCE

"The Cathodo-luminescence of Luminescent Calcium silicate"
by Ei-ichi Iwase and Satoyasu Iimori
Institute of Physical and Chemical Research
Scientific Papers vol 34 no 753 pp 173-181 - Jan. 1938

In order to confirm the suspicion that the yellow cathodo-luminescence exhibited by Japanese wollastonite and pectolite is to be ascribed to manganese, the content of that metal in the natural minerals was determined. Cathodo-luminescence bands as well as the manganese contents were compared with those results obtained in sinthetized materials

Wollastonite - several specimens of Japanese wollastonite were subjected to cathode-ray bombardment. All of them showed almost similar intense lemon-yellow luminescence. Spectrograms of the cathodo-luminescence were taken which gave two broad overlapping luminescence bands occupying a range of wave lengths from 49 mμ to 680 mμ with two crests at 580 mμ (highest) and 630 mμ.

In order to determine the effective luminescence activators

41 Orthocl
Apat
Graphite?
Diopside
Sphen
Quartz
Prehnite

363

(+) $V > r$

⊥X Y∠010 = 25° An ~~52%~~ 49% w — Same 24° = An ~~49%~~ 47% w

⊥Z X∠001 = 17 An ~~47%~~ 45% w — Same X∠001 = 23° ~~An 52%~~ An 50% w

⊥E.O. Pl E.O. ∠001 (?) = 28° = An 42% w

⊥X Z∠? (010?) = 32° An 46% w

⊥X Y∠010 = 24° (An 50%, An 44% w)

Flashfig ⊥Y {X∠010 = 8° ? ∠ ; ~~Z∠outrachir = 7° ?~~} (An 46%, An 45%) clivagens difíceis de ver não há twin

⊥EO Pl EO∠ = ±45 (An 50 w) 47 e 52%

Wa	Ni
52	49
49	47
47	45
52	50
50	42
46	46
	44
	45
	50
298	418

418 ÷ 9: 58, 40 → 46½

298 ÷ 6: 58, 40 → 49½

27 Plag

X / 001 = 17° (An 45%)

X / 010 = 12-18° - An 45%)

(+)

Anfib Z/c = 10°, 13°, 11°

Z = medium greenish orange brown (orange +(burnt sienna)

X - very pale light orange brown

$N_Z - N_X$ - 0,20-0,25 (1st order blue ~~violet~~)

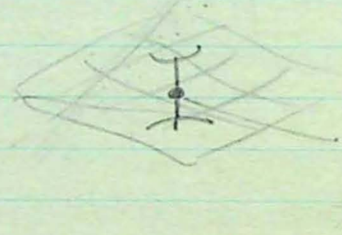
(green in center of section

red violet in border

~~Y~~ - rose brown (close to Burnt carmine 4/6

Absorption formula X<Z<Y

V > r medium



$b x_0$ (?

(-)

48

Plag perto do leteiro (-) V > r

Angle between cleavages in section normal to optic axes = 75 (68-76)

Optic plane ∠ 010 = 60° = An 70%

Optic plane ∠ 001 = 18° = An 76% *

Optic plane ∠ 001 = 25° An 84% *

Opt pl ∠ ~~010~~ = 60° An 70

60°

240	248
172	172
68	76

⊥X Z/010 = 55° An 80%

295 opt pl = ~~60°~~ ⊥Y X∠ 010 = 30½° = An 80% *

⊥X Z∠010 =

BITOWNITA (An 76% average)

70
76
84
70
80
80
460
40

76