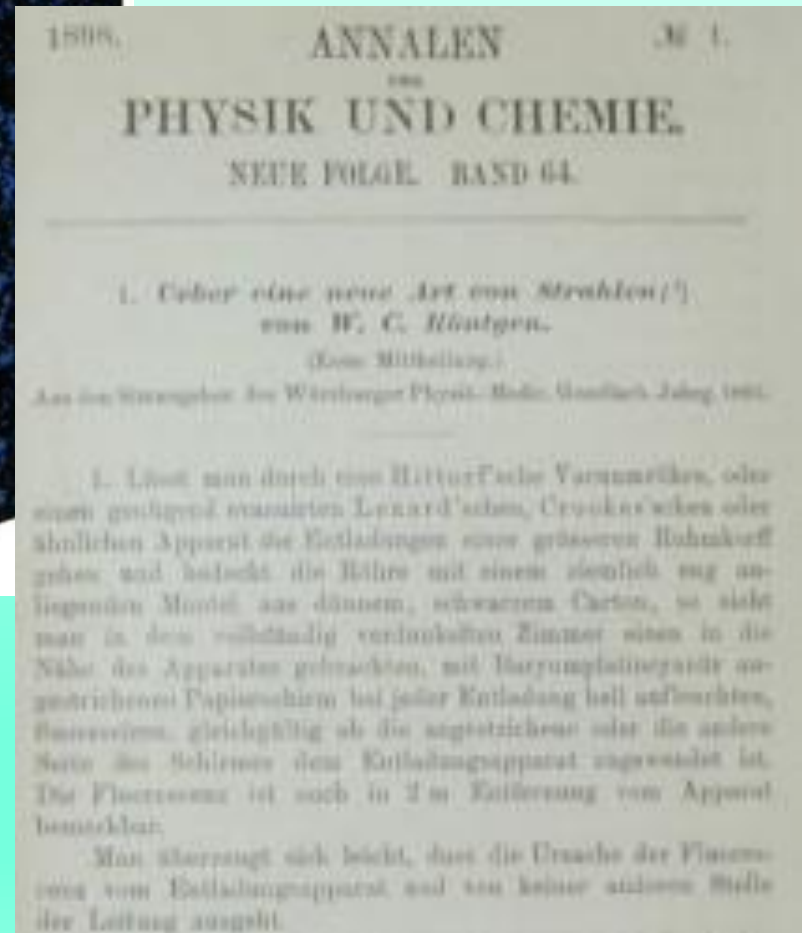


PRINCÍPIOS DE
DIFRAÇÃO DE RAIOS X

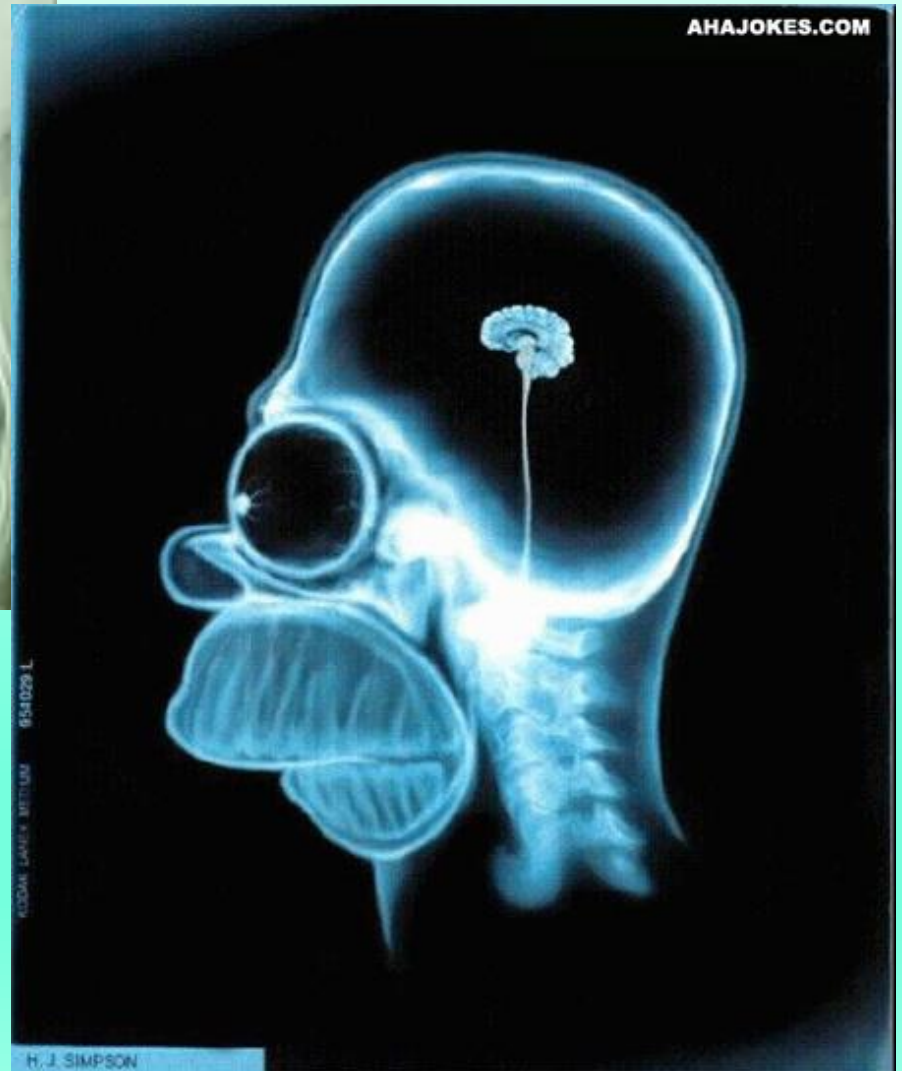
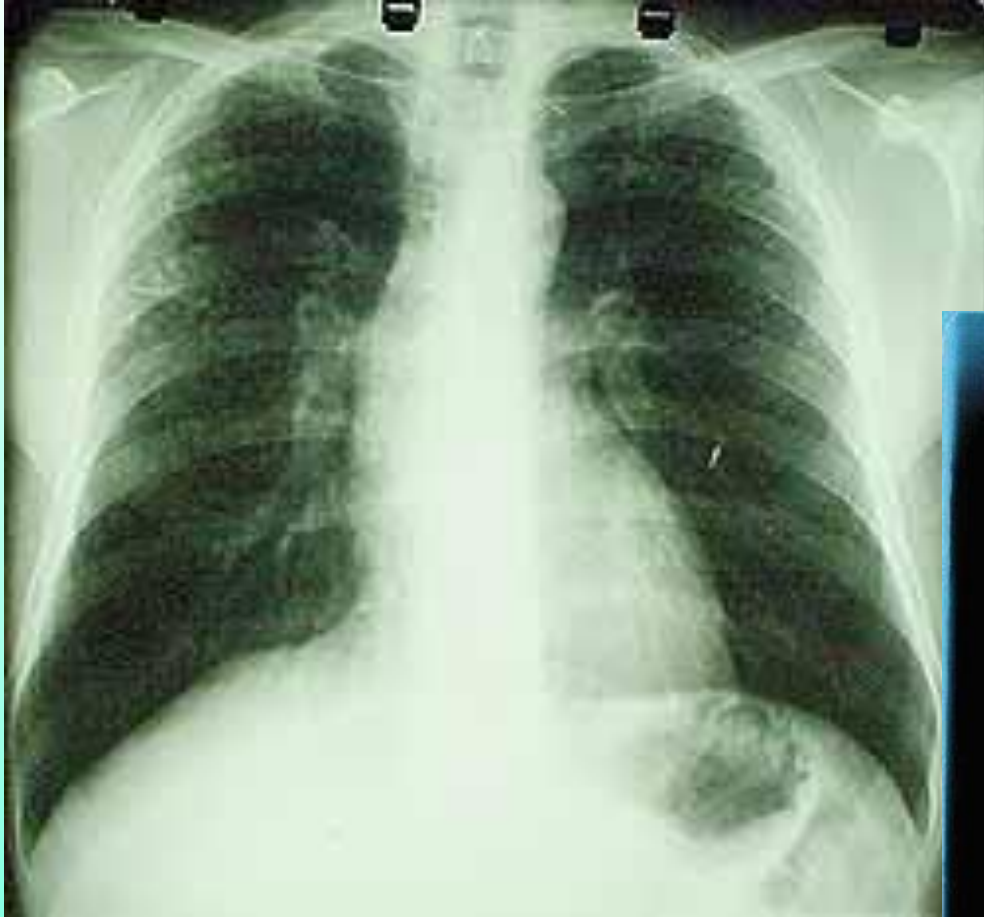
DANIEL ATENCIO



1895 – Röntgen:
descoberta dos
raios X

utilização na medicina



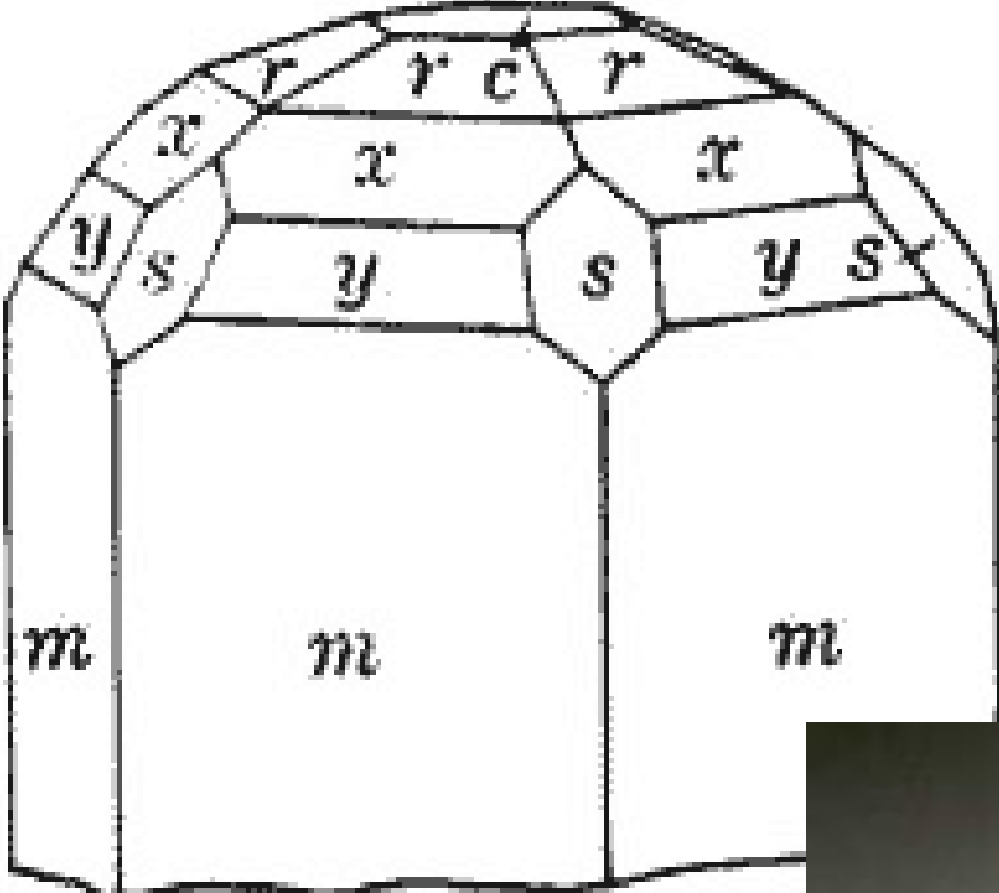


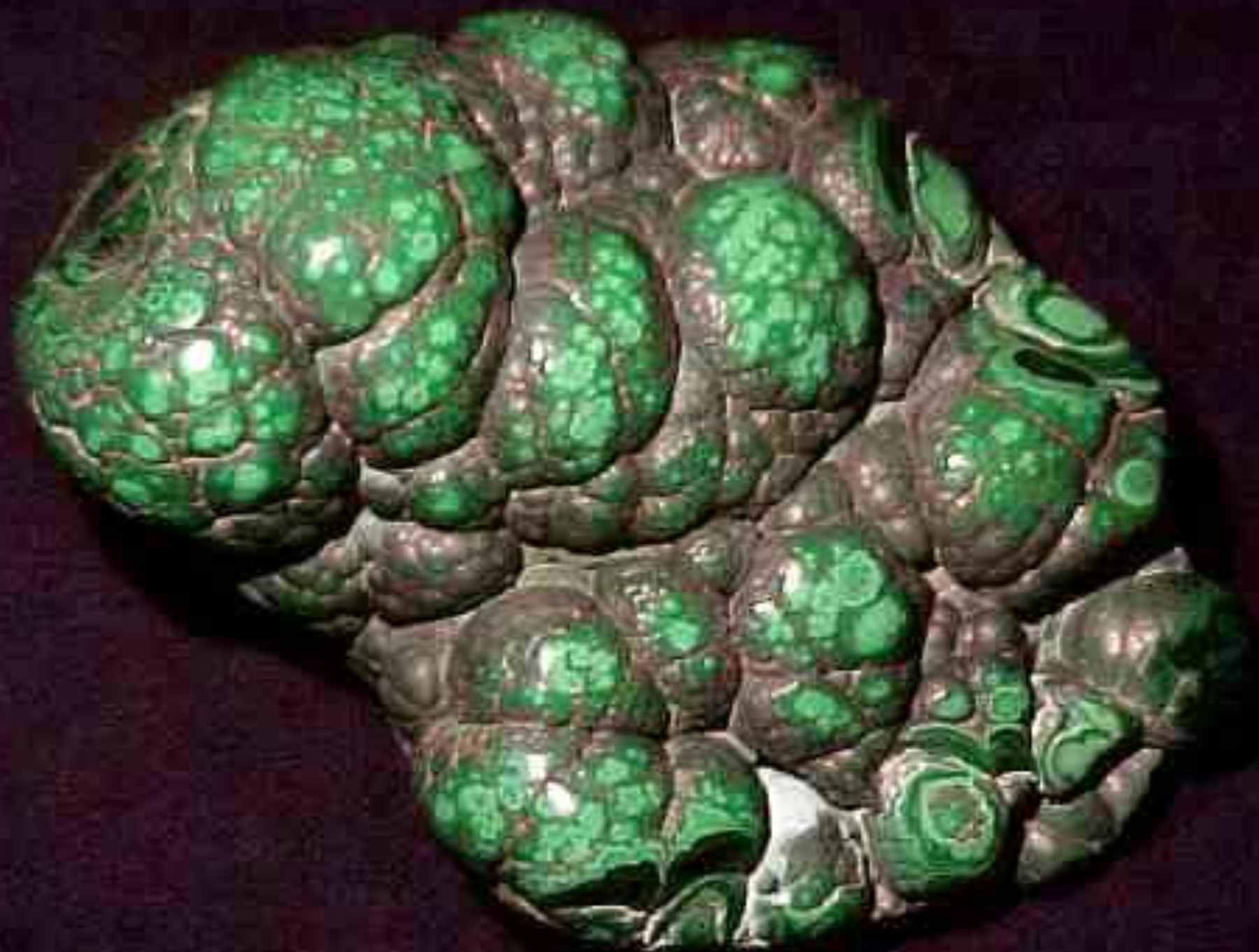


WILHELM CONRAD RÖNTGEN

Das Buch
Der Film









X-RAY SPECS

ONLY \$1⁰⁰

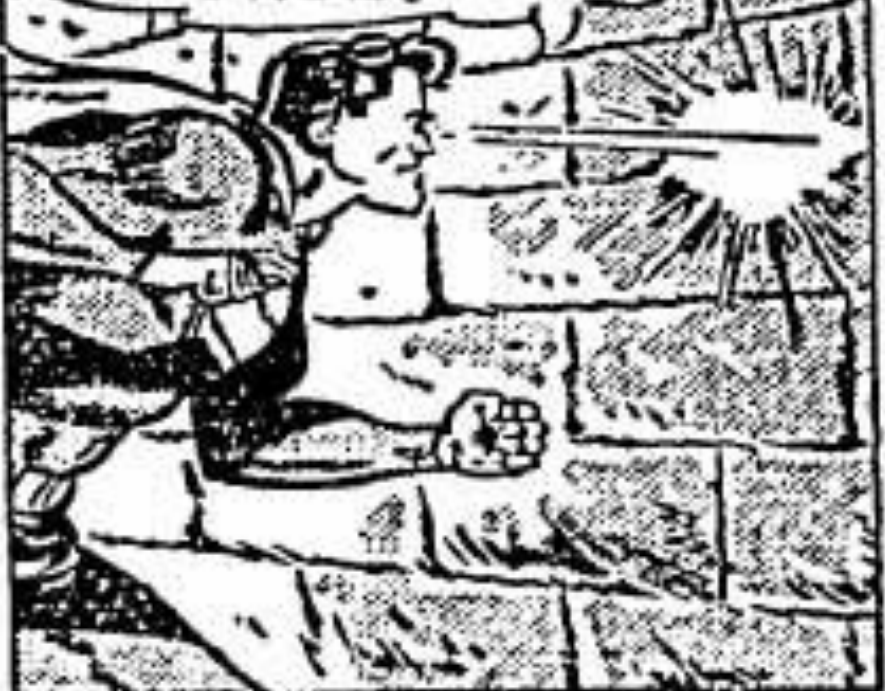
An Hilarious Optical Illusion

Scientific optical principle really works. Imagine—you put on the "X-Ray" Specs and hold your hand in front of you. You seem to be able to look right through the flesh and see the bones underneath. Look at your friend. Is that really his body you "see" under his clothes? Loads of laughs and fun at parties. Send only \$1 plus 25c shipping charges. Money Back Guarantee.

HONOR HOUSE PRODUCTS CORP., Lynbrook, N.Y. Dept. 97XR02

SUPERMAN'S X-RAY VISION PENETRATES THE PENITENTIARY.

IF THERE WERE ONLY A WAY TO PREVENT CRANDALL'S DEATH WITHOUT THWARTING JUSTICE!

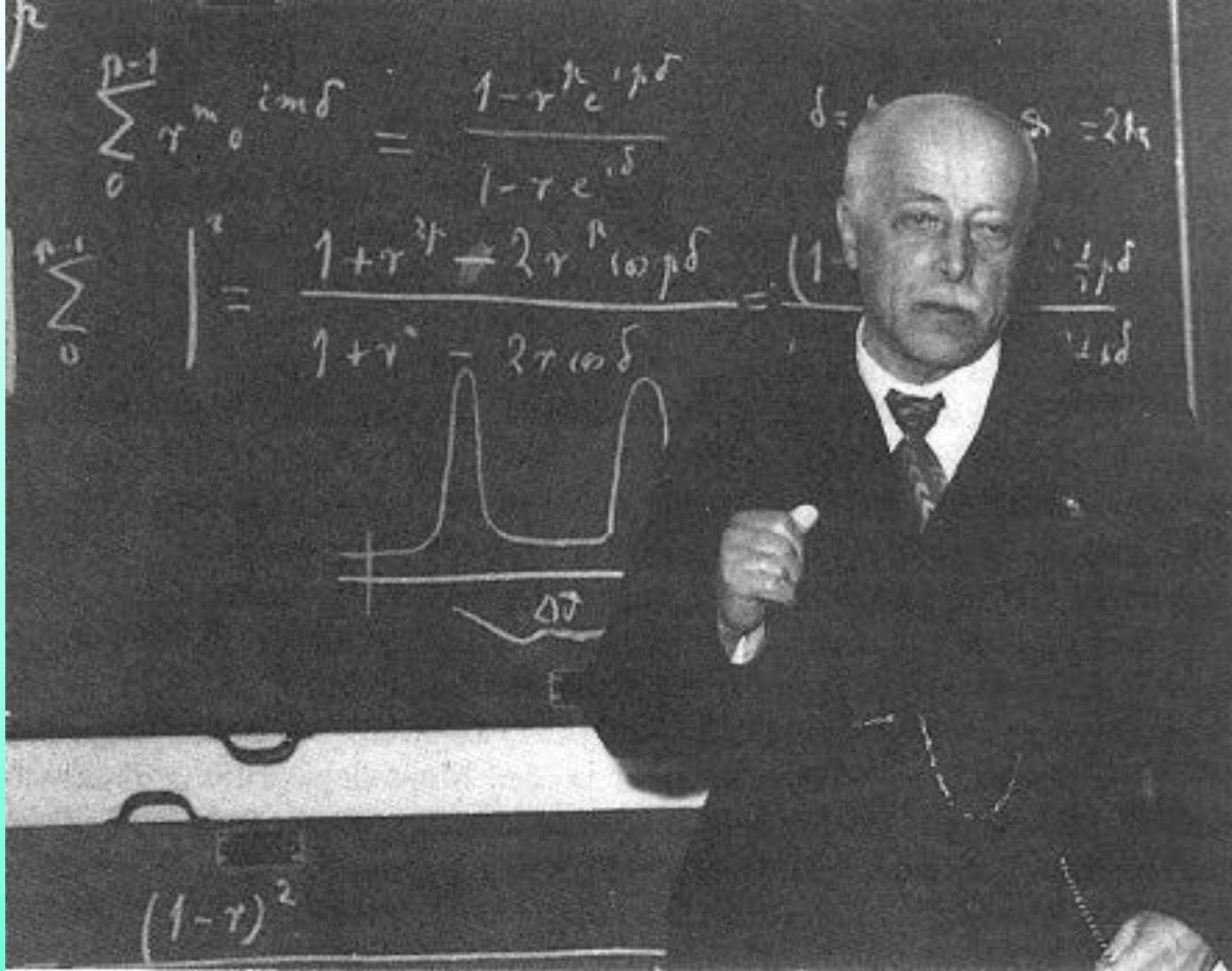


AFTER CLARK SWITCHES, UNSEEN, TO SUPERMAN, HE FLIES TO JIMMY'S APARTMENT...



CLARK TOLD ME ABOUT YOUR TOOTHACHE!... HMM-M. MY X-RAY VISION REVEALS YOU'VE GOT A BAD CAVITY IN A BACK MOLAR! BETTER SEE YOUR DENTIST IMMEDIATELY!

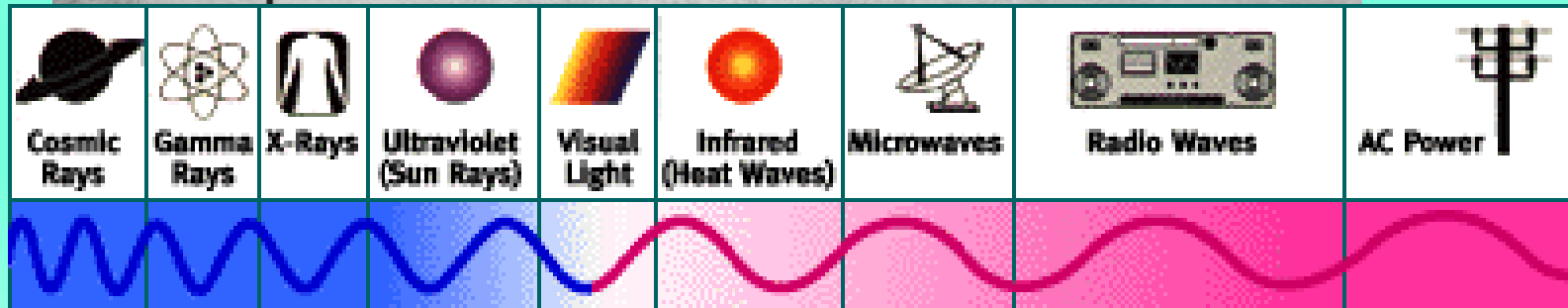
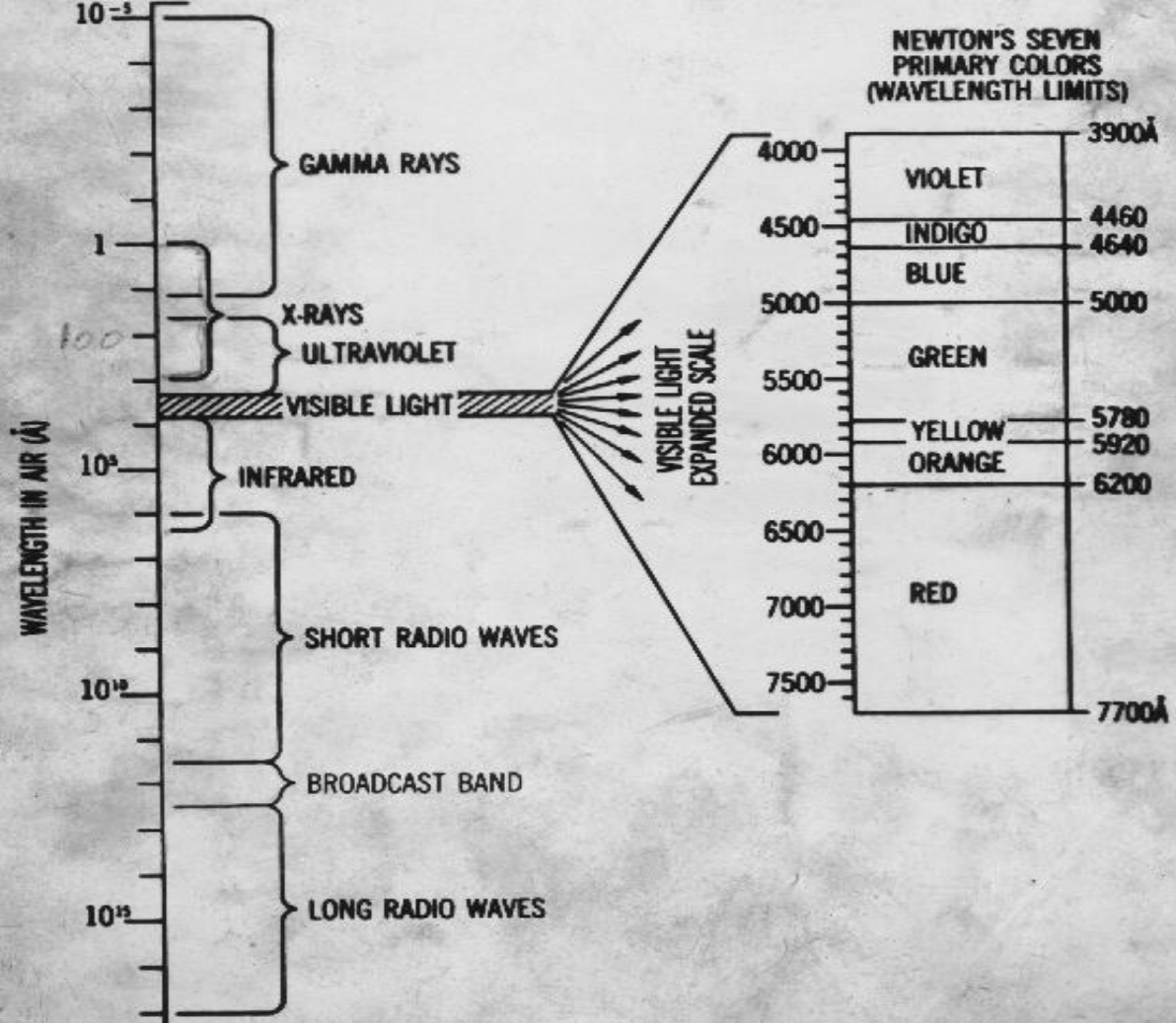
Authorized dealers and is sold subject to the conditions part of its cover or markings removed, nor in a mutilated advertising, literary or pictorial matter whatsoever."



1912 – von Laue – interação
raios X - cristais

Interferência:

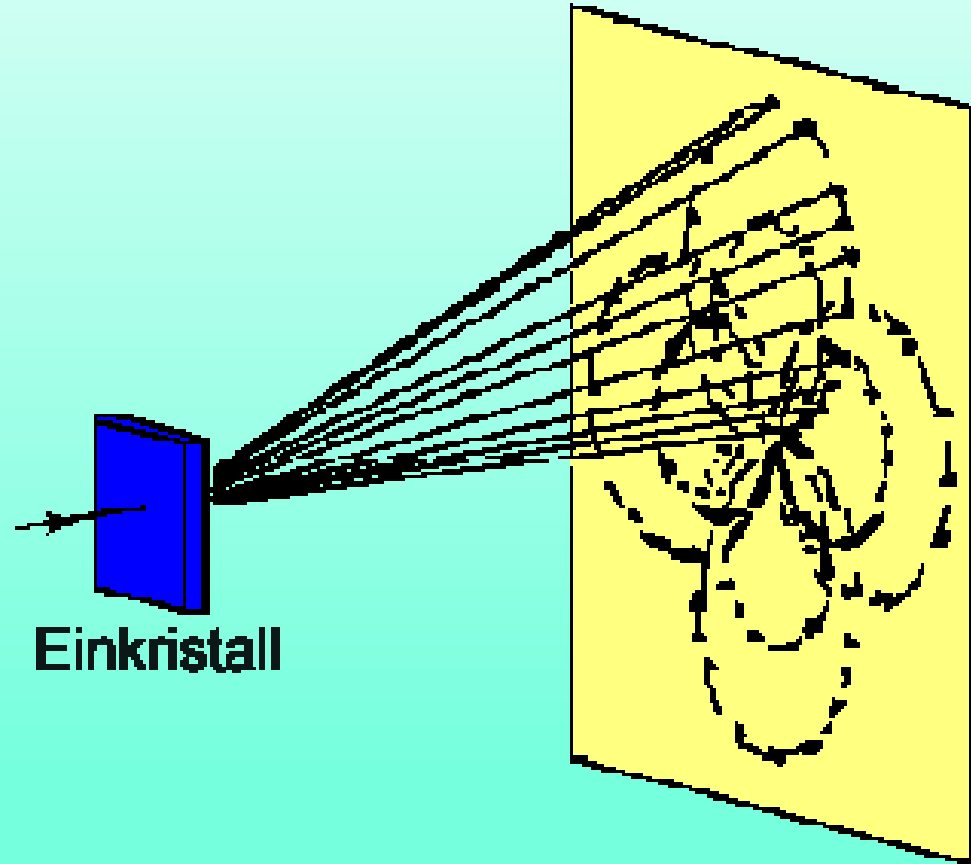
as ondas produzem efeitos de interferência quando difundidas por objetos separados a distâncias equivalentes ao comprimento das ondas.



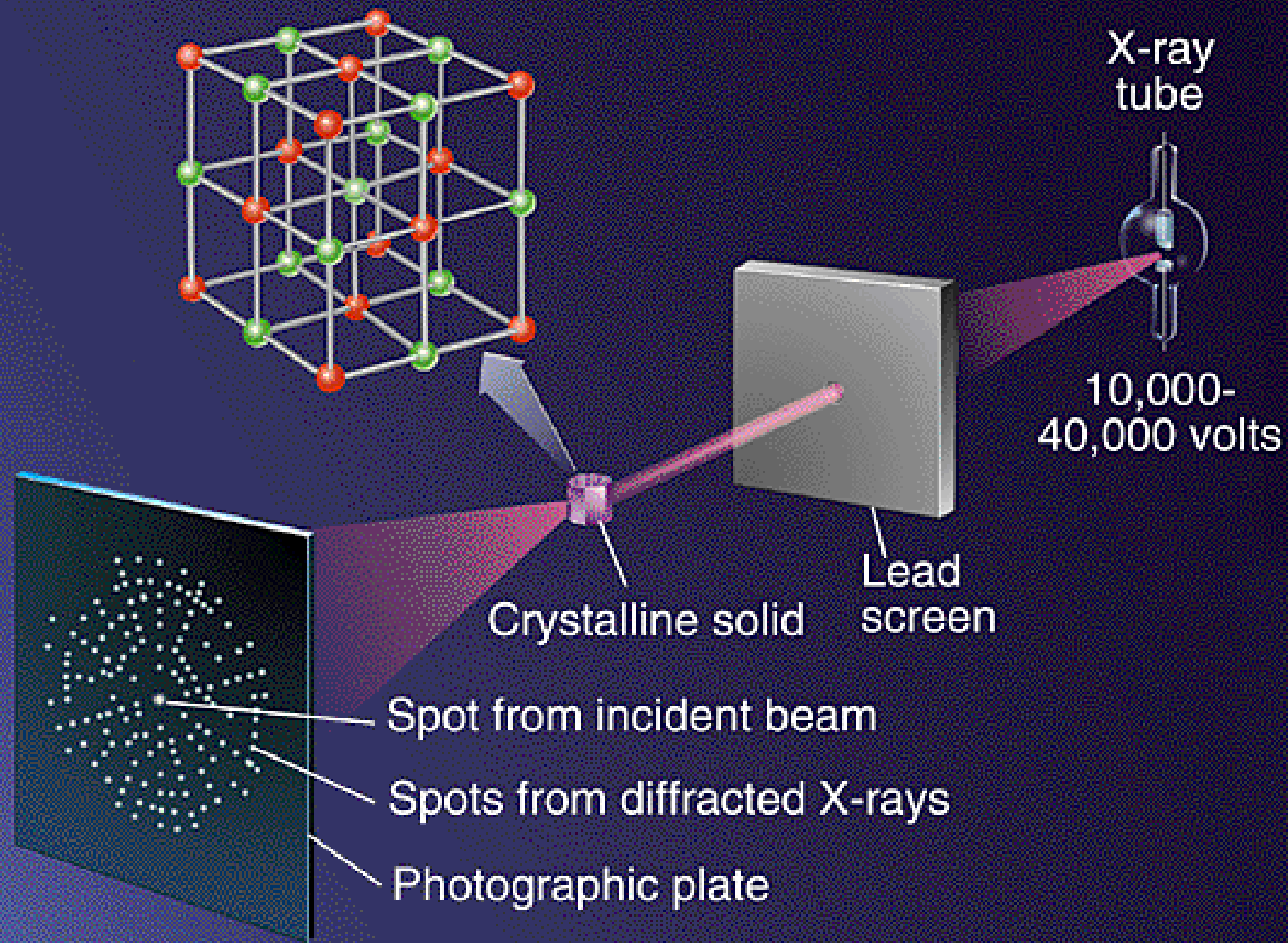
High Frequency
(Short Wavelengths)

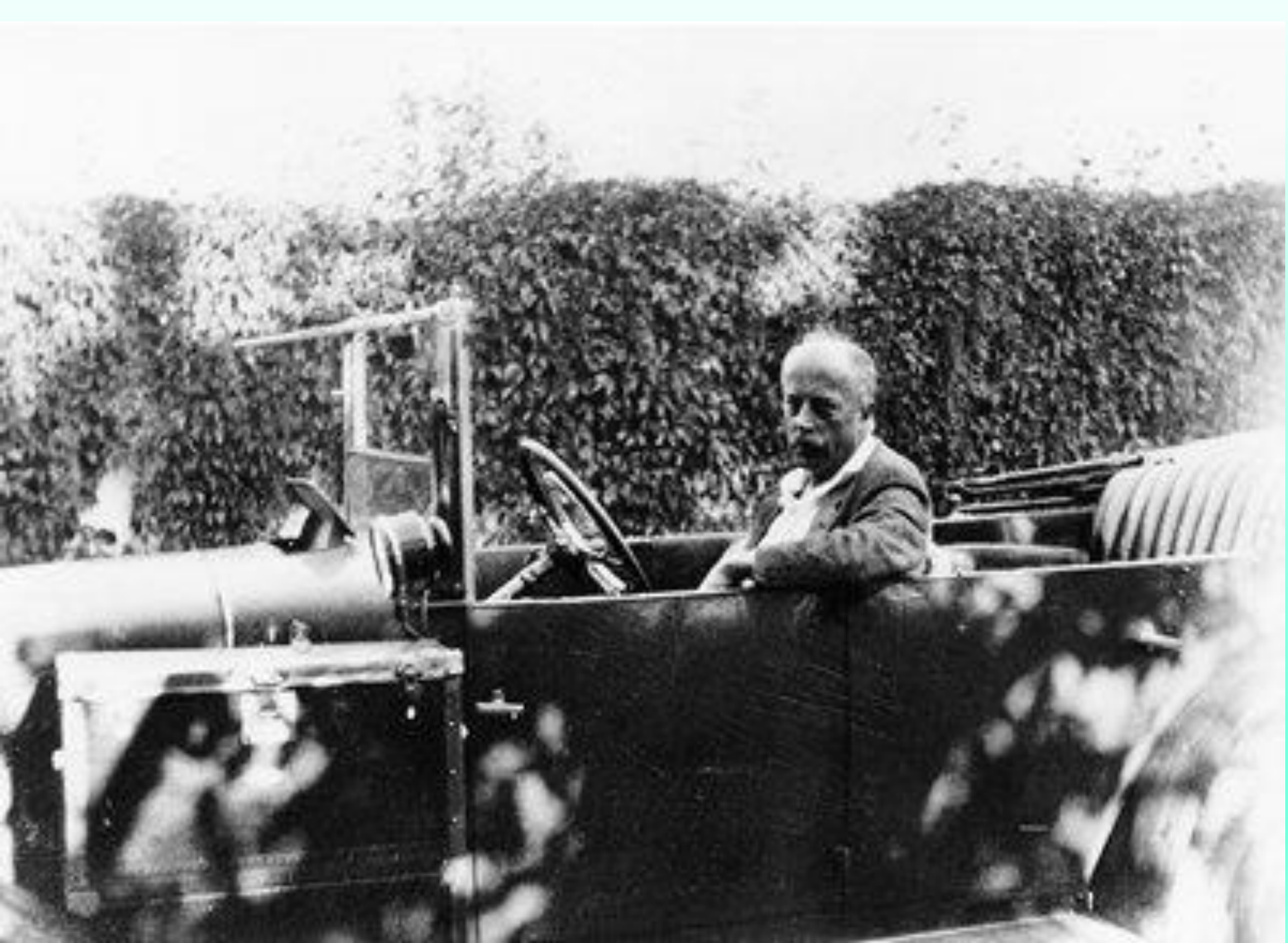
Low Frequency
(Long Wavelengths)

Experimentos de Laue: calcantita – triclínico



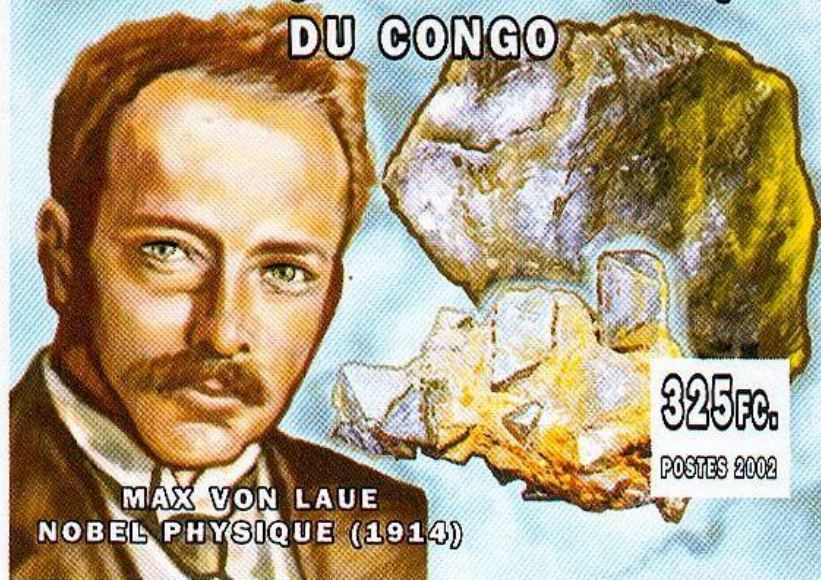
depois: cristais cúbicos







REPUBLIQUE DEMOCRATIQUE
DU CONGO



MAX VON LAUE
NOBEL PHYSIQUE (1914)

325Fc.
POSTES 2002

IMPRESSOR S.A.



SVERIGE
65

von LAUE
NOBELPRIS 1914

LEINART FORSBERG

1974

ARNE WALDHORN



MAX VON LAUE

DDR

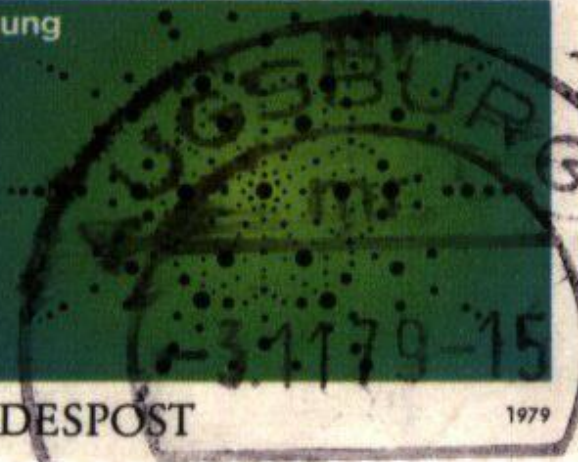
10

MAX VON LAUE * NOBELPREIS PHYSIK 1914

Röntgenstrahl-Beugung
am Kristallgitter

DEUTSCHE BUNDESPOST

1979

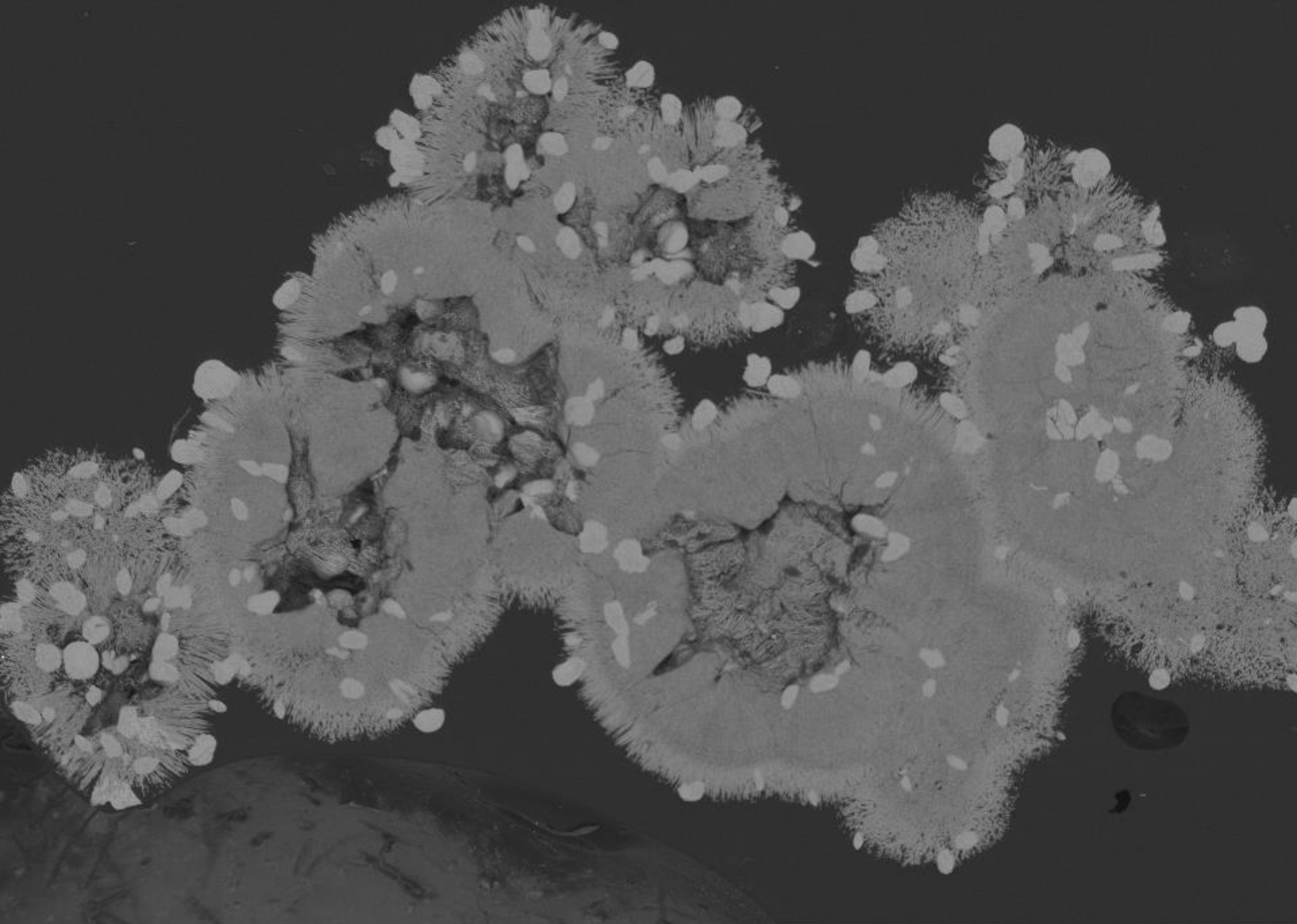


Utilidade:

Desde a simples identificação de substâncias cristalinas, até a determinação da posição de cada átomo na estrutura



2 mm



0µm

WD = 25 mm

Detector = QBSD

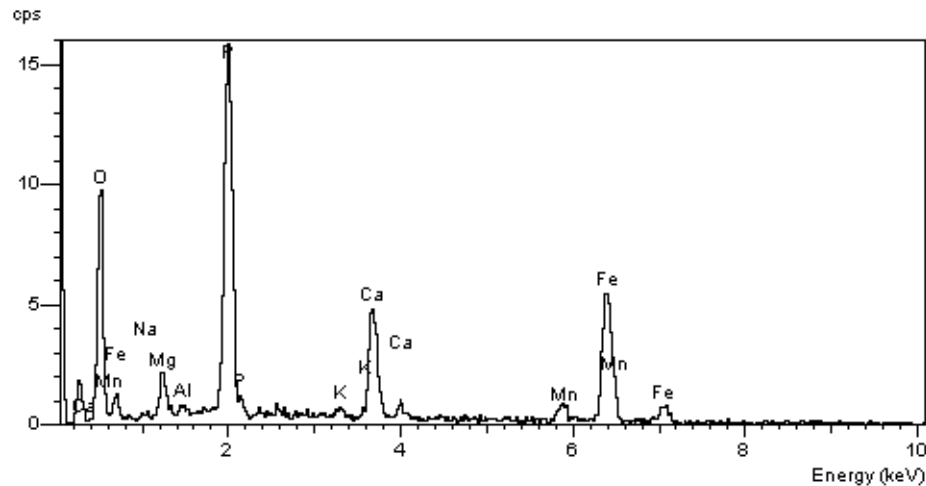
Mag = 50 X

LCT - LEO 440

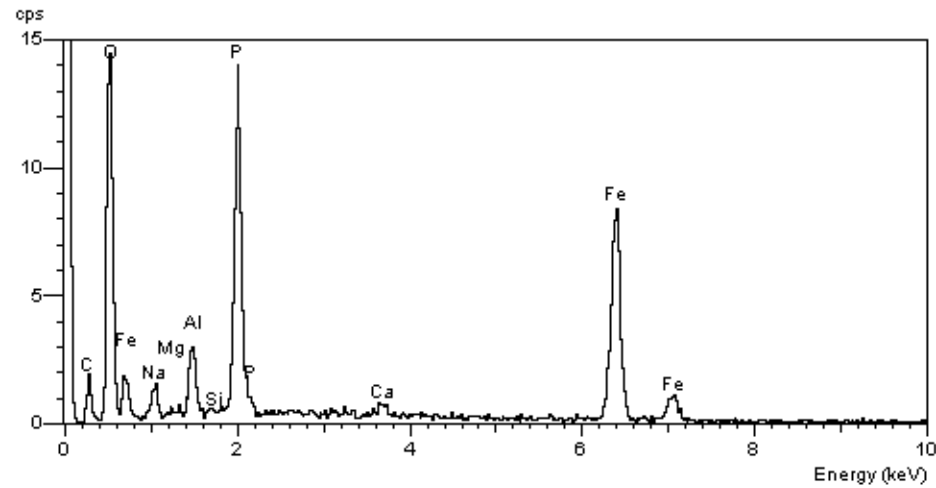
S1

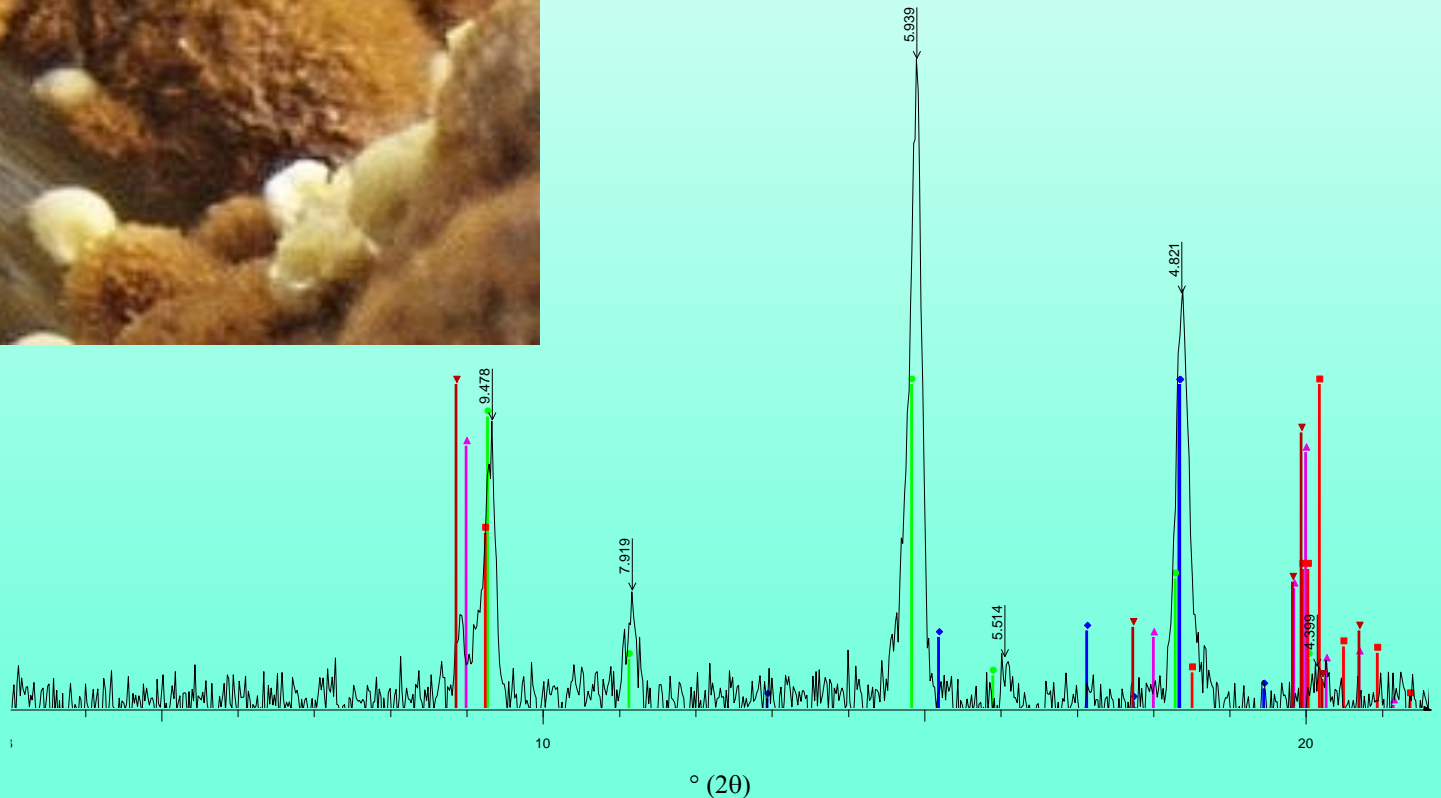
ENV = 20.00 kV

Ruifrancoíta,
 $\text{Ca}_2(\square, \text{Mn}^{2+})_2$
 $(\text{Fe}^{3+}, \text{Mg}, \text{Mn}^{2+}, \text{Fe}^{2+}, \text{Al})_4 \text{Be}_4$
 $(\text{PO}_4)_6 (\text{OH})_4 (\text{OH}, \text{H}_2\text{O})_2 \cdot 4\text{H}_2\text{O}$



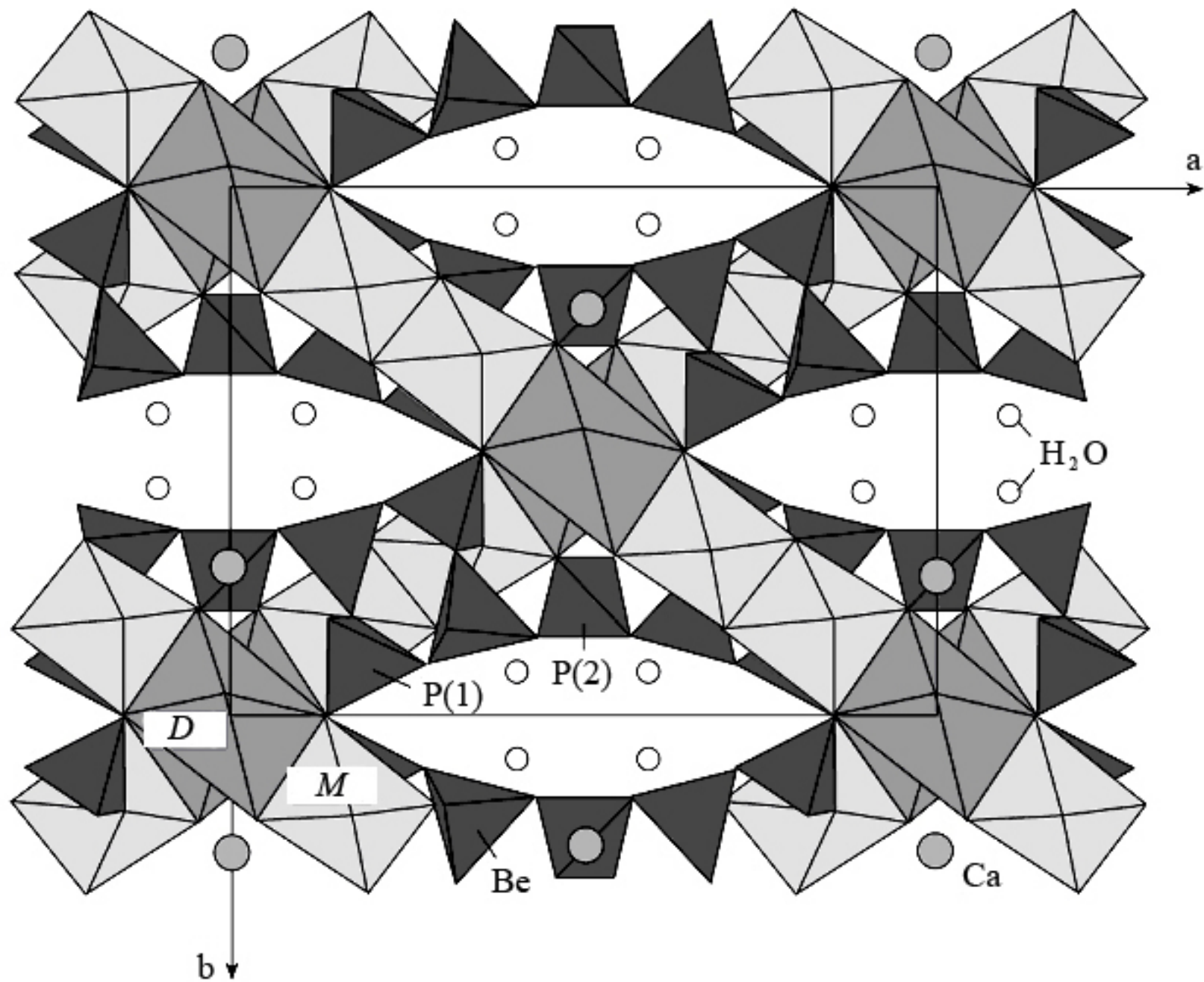
Cyrllovita - $\text{NaFe}_3+3[(\text{OH})_2|\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$



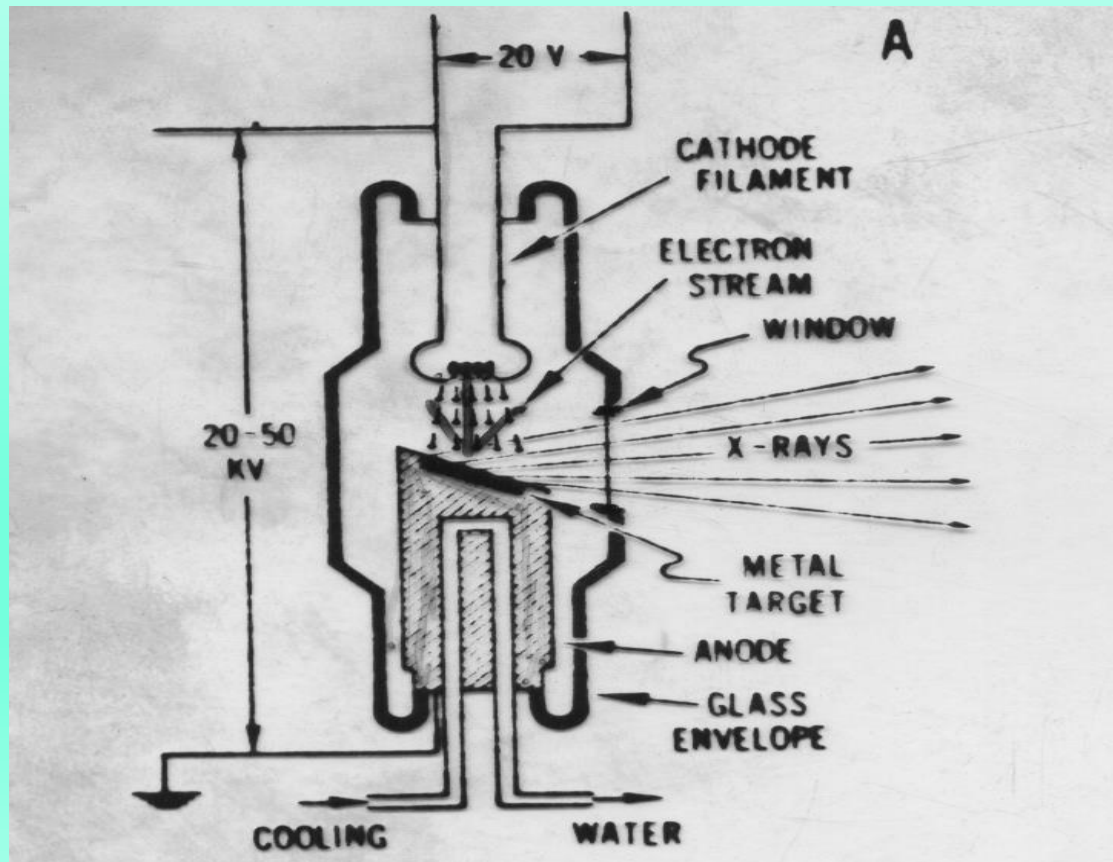


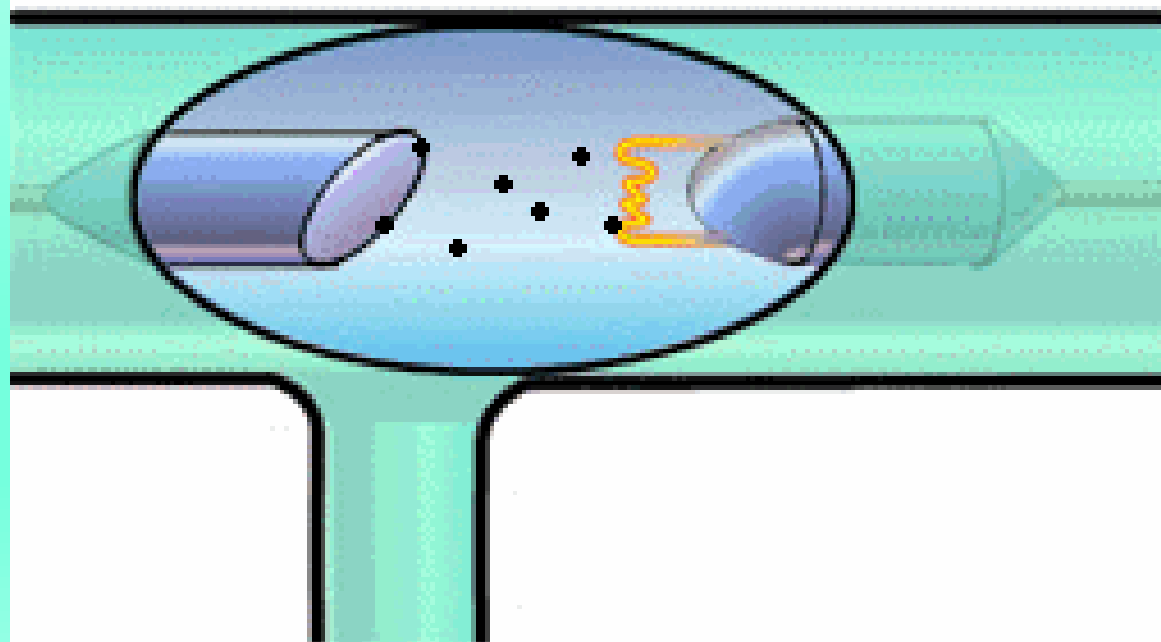
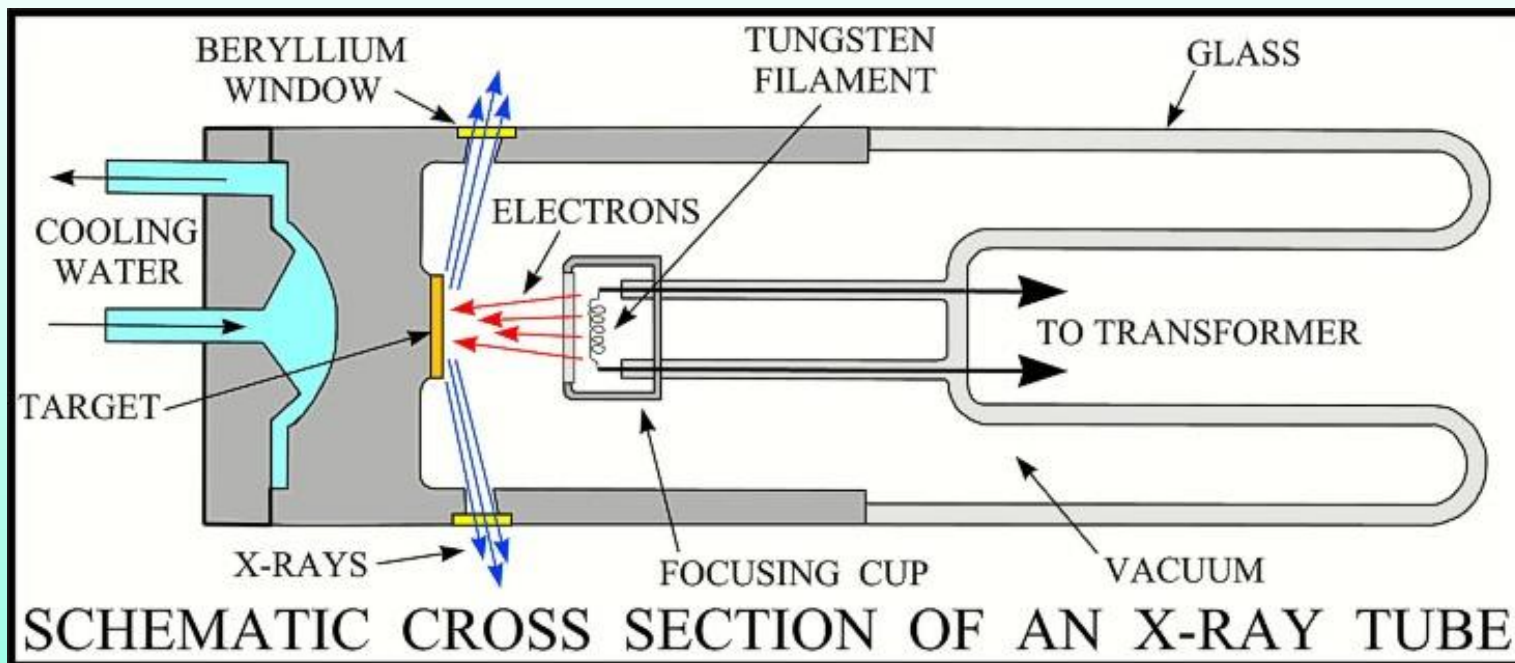
S1lento - File: S1lento.RAW - Type: 2Th/Th locked - Start: 3.00 ° - End: 80.00 ° - Step: 0.02 ° - Step time: 5. s - Temp.: 25 °C (Room) - Time Started: 36 s - 2-Theta: 3.00 ° - Theta: 1.50 ° - Phi: 0.00 ° - Aux1: 0.0 - Aux2: 0.0 - Aux3:

- ◆ 85-1315 (C) - Cyrillivite - NaFe₃(OH)₄(PO₄)₂(H₂O)₂ - Y: 50.00 % - d x by: 1. - WL: 1.54056 - Tetragonal - a 7.31300 - b 7.31300 - c 19.31500 - alpha 90.000 - beta 90.000 - gamma 90.000 - Primitive - P41212 (92) - 4 - 1032.97
- 11-0355 (I) - Roscherite-M - (Ca,Mn)₃Be₃(PO₄)₃OH₃·2H₂O - Y: 50.00 % - d x by: 1. - WL: 1.54056 - Monoclinic - a 15.972 - b 11.934 - c 6.622 - alpha 90.000 - beta 95.25 - gamma 90.000 - Base-centred - C2/c (15) - 4 - 1256.9
- ▲ 85-2147 (C) - Muscovite 2M1 - (Na_{0.37}K_{0.60})(Al_{1.84}Ti_{0.02}Fe_{0.10}Mg_{0.06})(Si_{3.03}Al_{0.97})O₁₀(OH)₂ - Y: 50.00 % - d x by: 1. - WL: 1.54056 - Monoclinic - a 5.174 - b 8.975 - c 19.76999 - alpha 90.000 - beta 95.2 - gamma 90.000
- ▼ 86-1386 (C) - Muscovite 2M1 - K_{0.94}Al_{1.96}(Al_{0.95}Si_{2.85}O₁₀)(OH)_{1.744}F_{0.256} - Y: 50.00 % - d x by: 1. - WL: 1.54056 - Monoclinic - a 5.18050 - b 8.99400 - c 20.08600 - alpha 90.000 - beta 95.740 - gamma 90.000 - Base-centred - C2/c (15) - 4 - 1256.9
- 82-2452 (C) - Muscovite 2M1 - (Na_{0.37}K_{0.60})(Al_{1.84}Ti_{0.02}Fe_{0.10}Mg_{0.06})(Si_{3.03}Al_{0.97})O₁₀(OH)₂ - Y: 50.00 % - d x by: 1. - WL: 1.54056 - Monoclinic - a 5.130 - b 8.886 - c 19.241 - alpha 90.000 - beta 95.5 - gamma 90.000



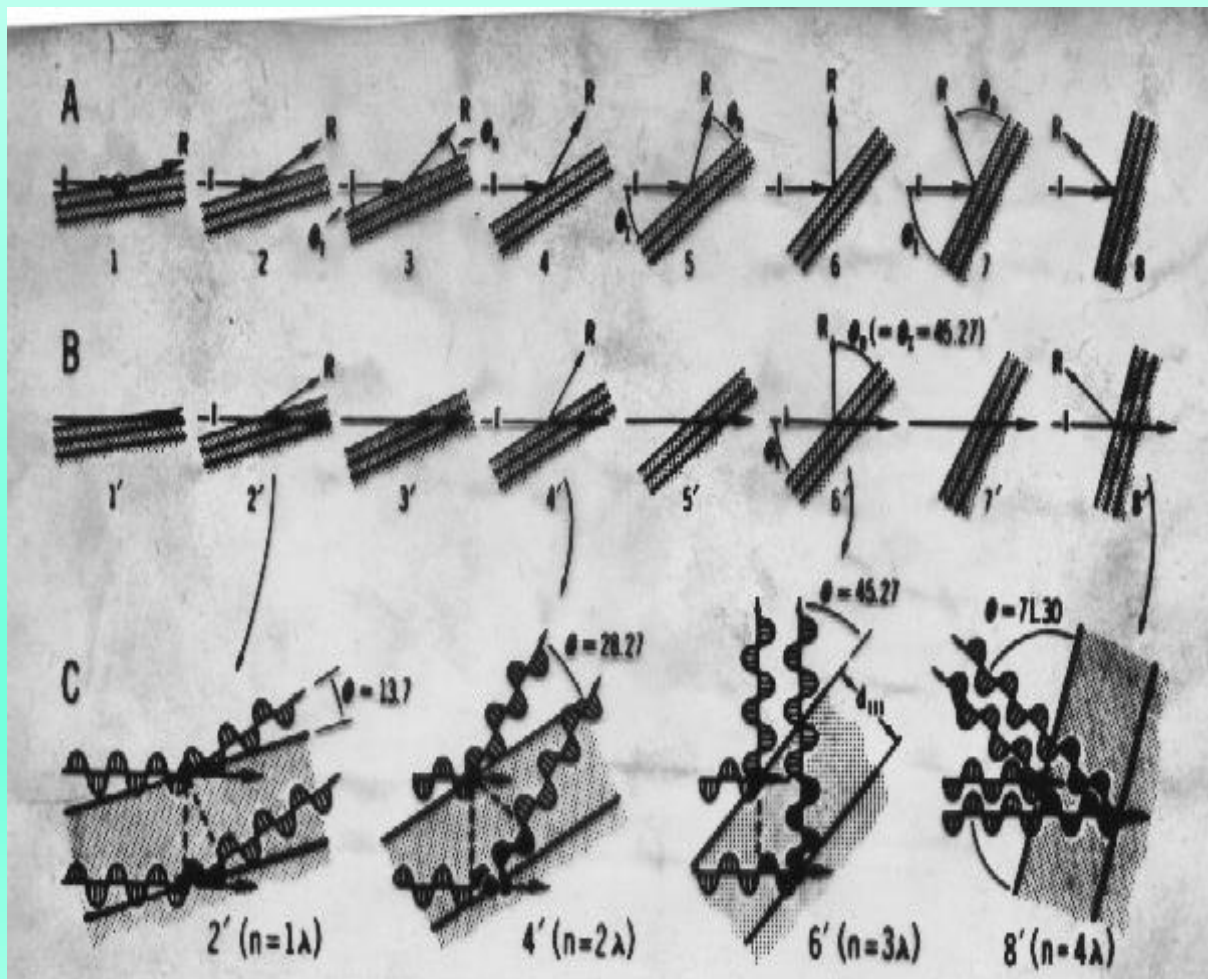
Produção de raios X:
Tubo de raios X:
tipos de metais utilizados:
Mo, Cu, Ni, Co, Fe

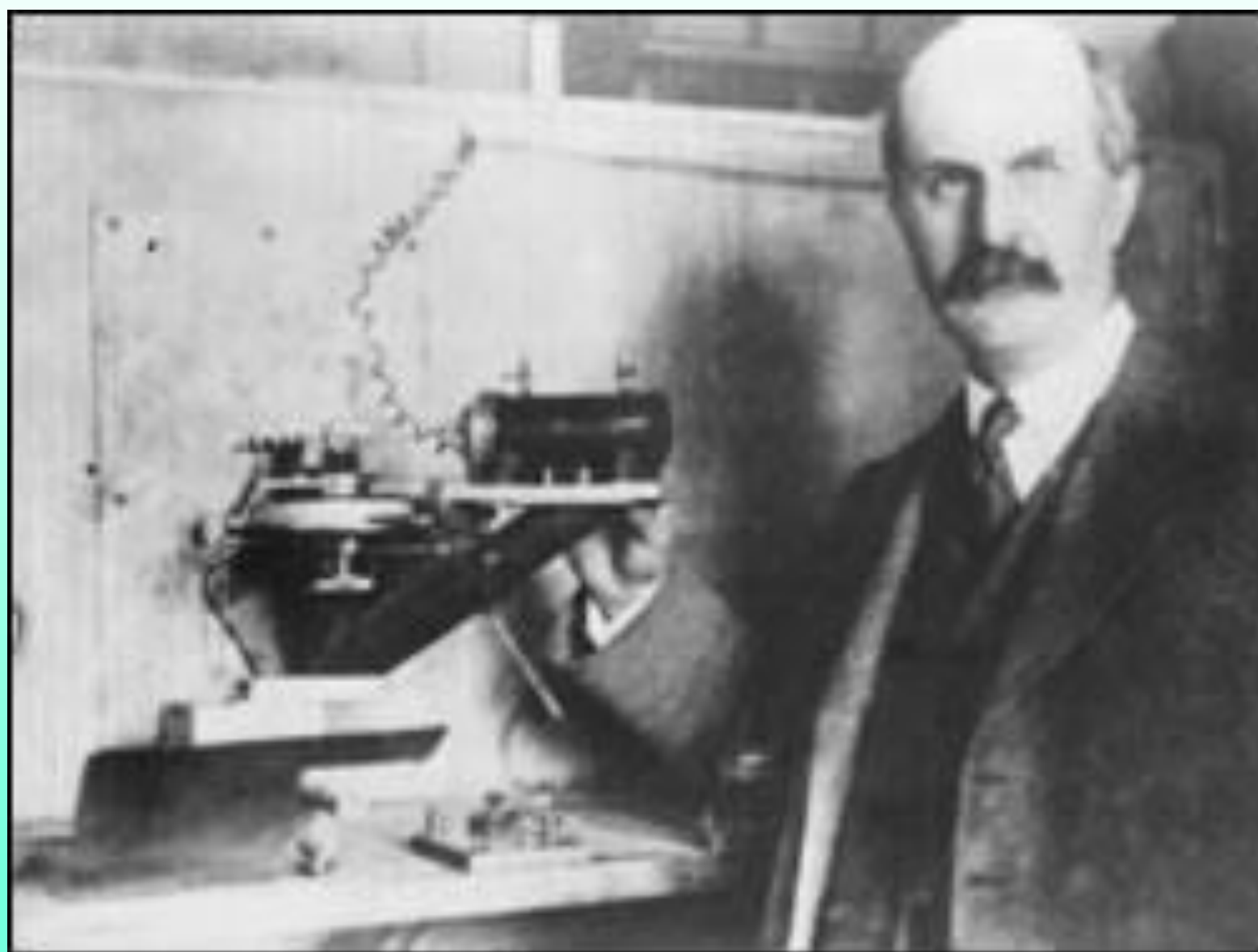




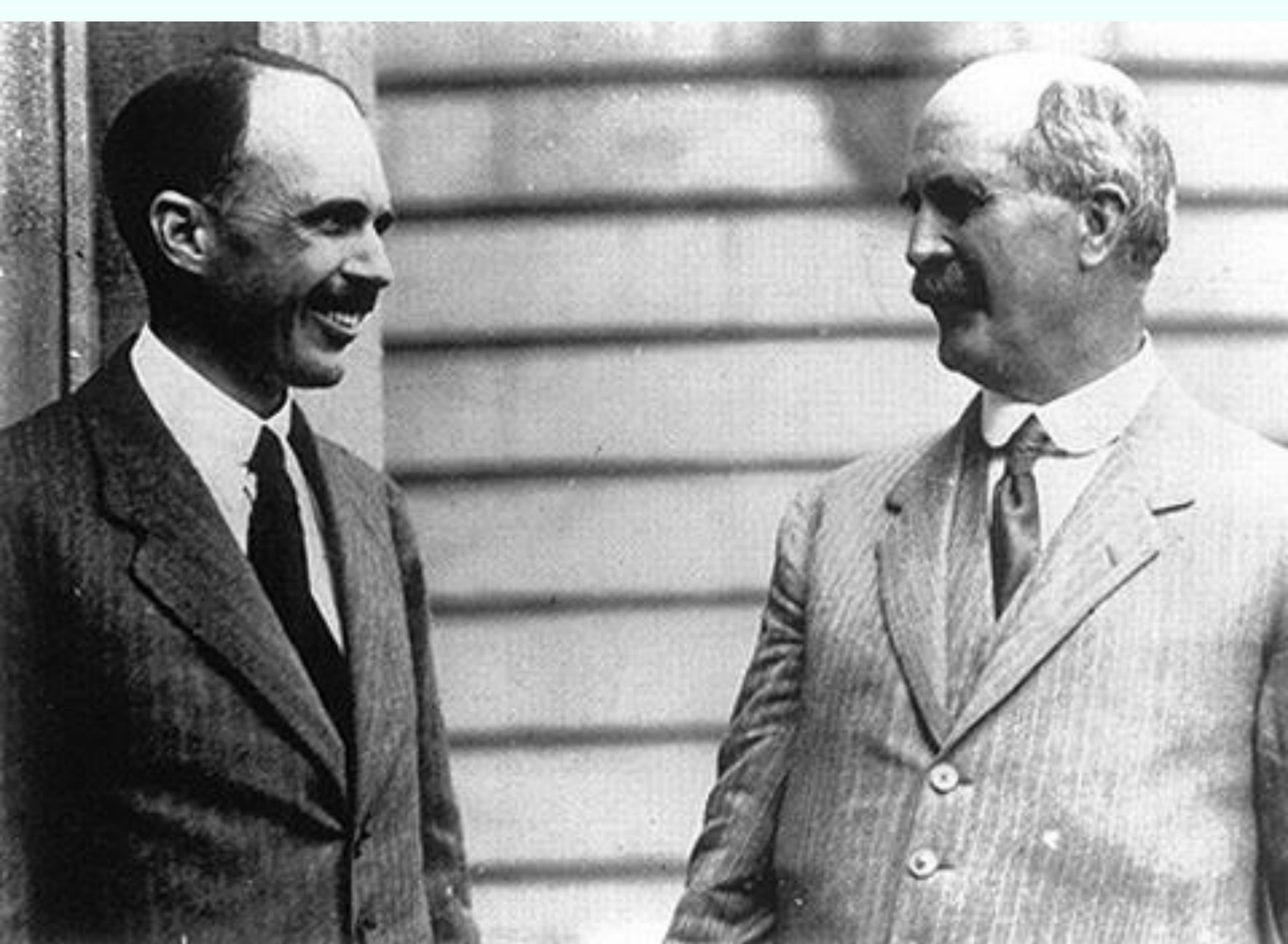
Difração de raios X em retículos cristalinos:

diferença entre reflexão da luz por um espelho e reflexão dos raios X por uma camada de átomos do cristal.

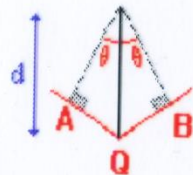
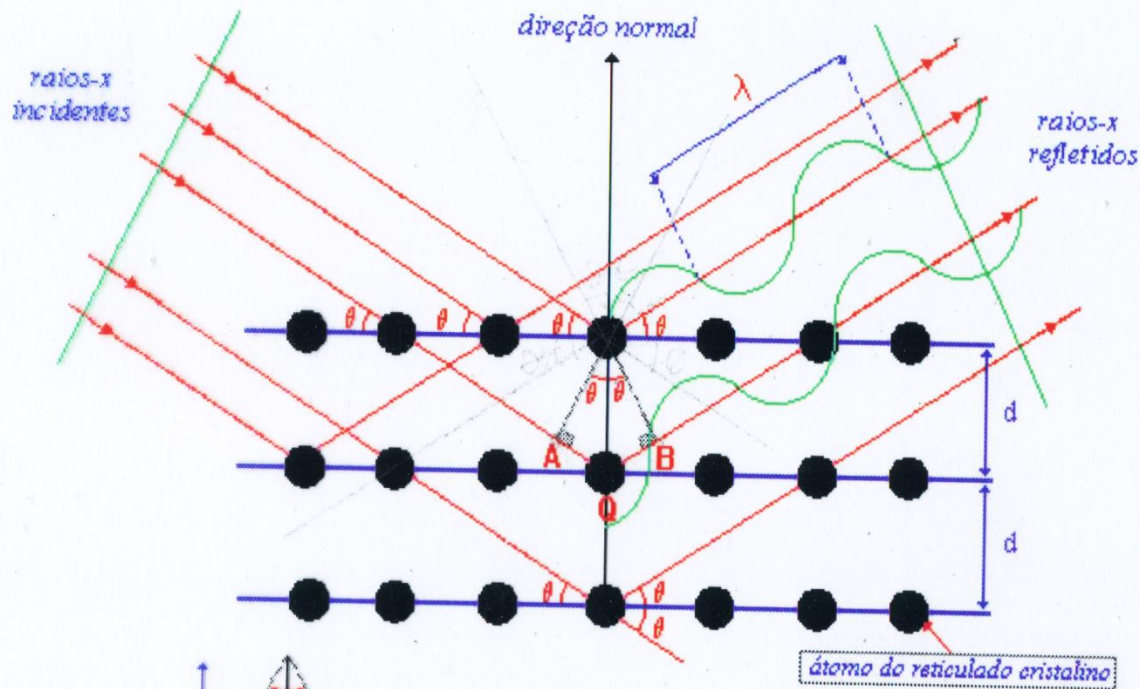




W.H. Bragg and his X-ray spectrometer at University College, London.



Lei de Bragg

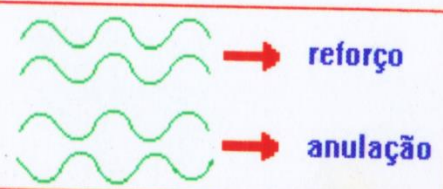


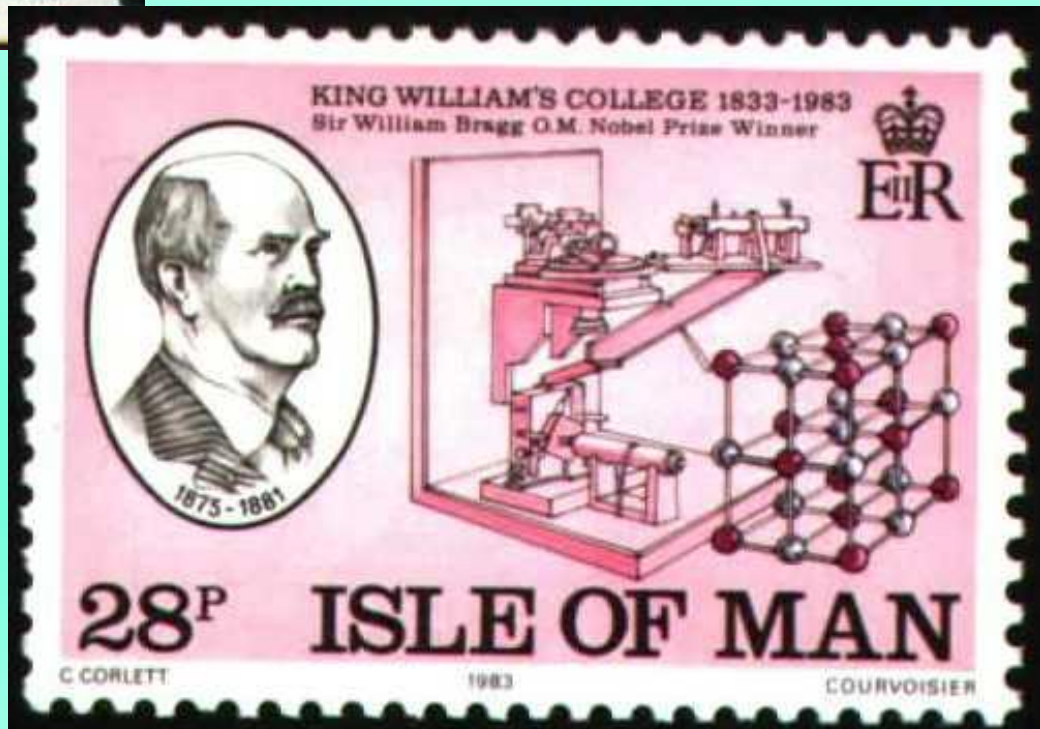
$$\overline{AQ} + \overline{QB} = n\lambda \rightarrow 2d \sin\theta = n\lambda$$

d - distância interplanar

θ - ângulo de incidência do feixe de raios-X

λ - comprimento de onda do feixe de raios-X





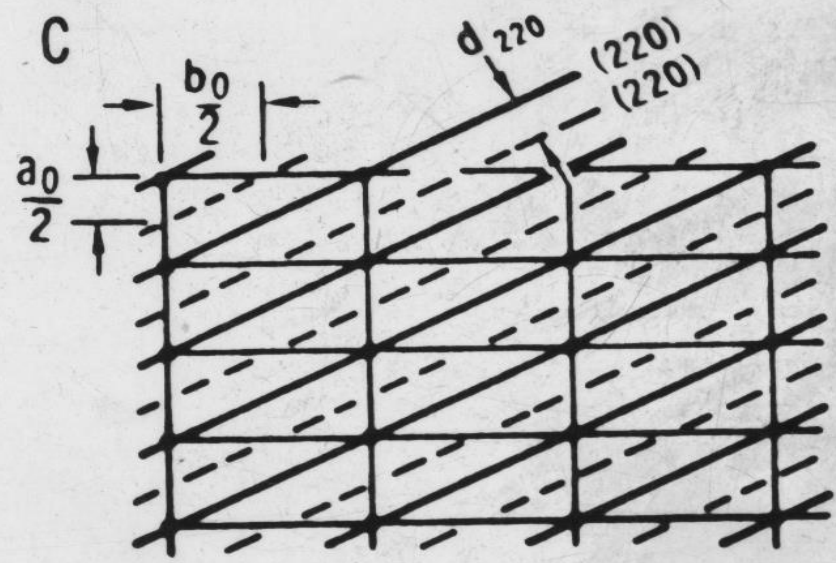
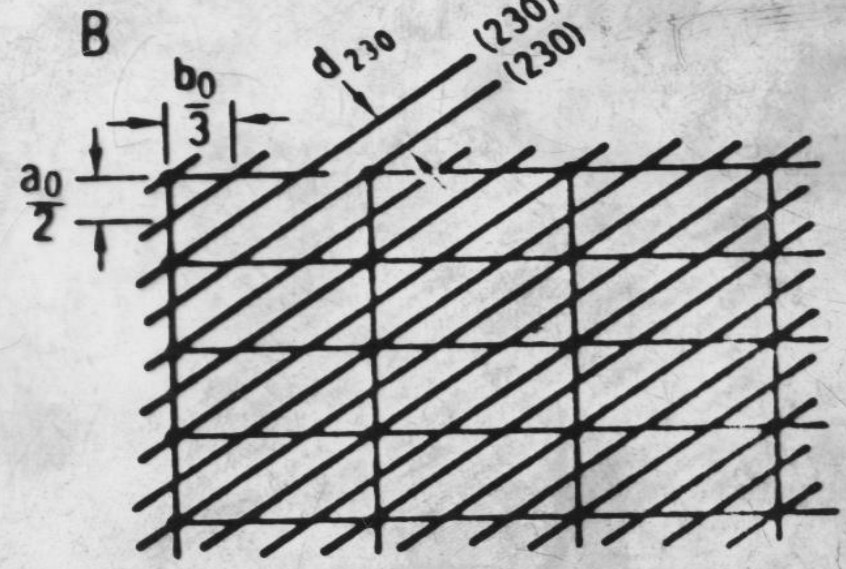
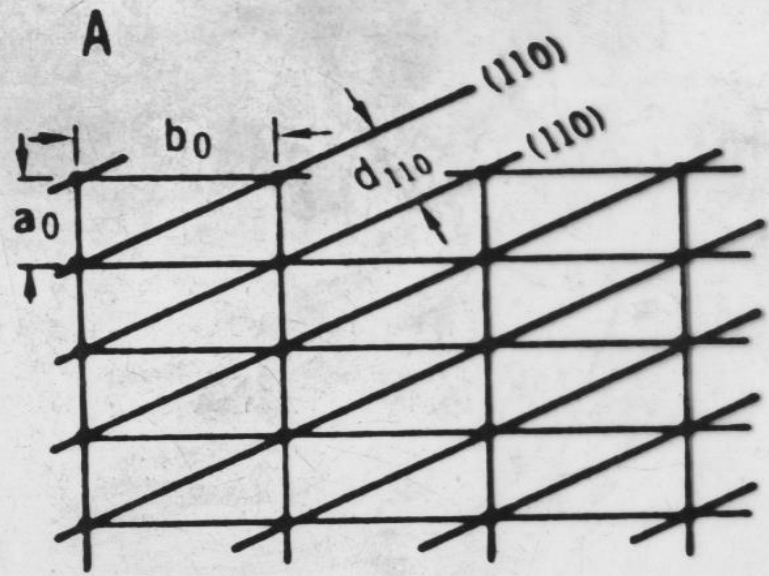


Bragg e Pauling

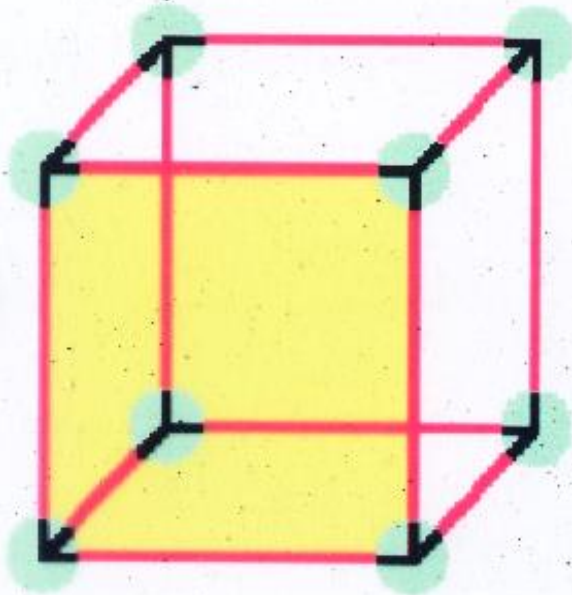


Scanned at the American
Institute of Physics

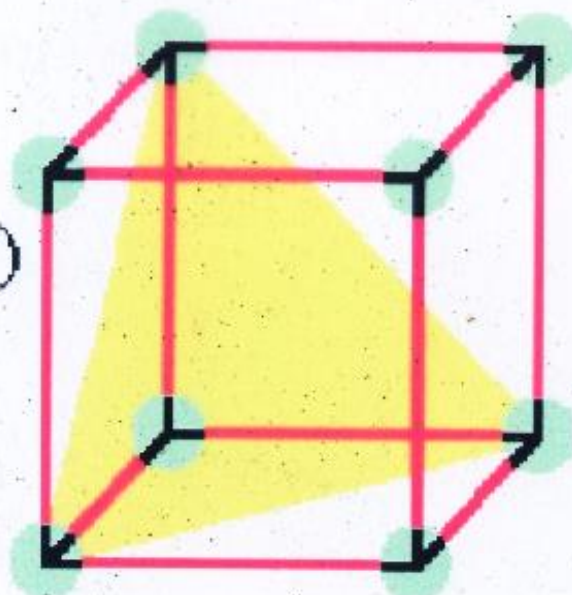
Bragg, Laue, Fankuchen



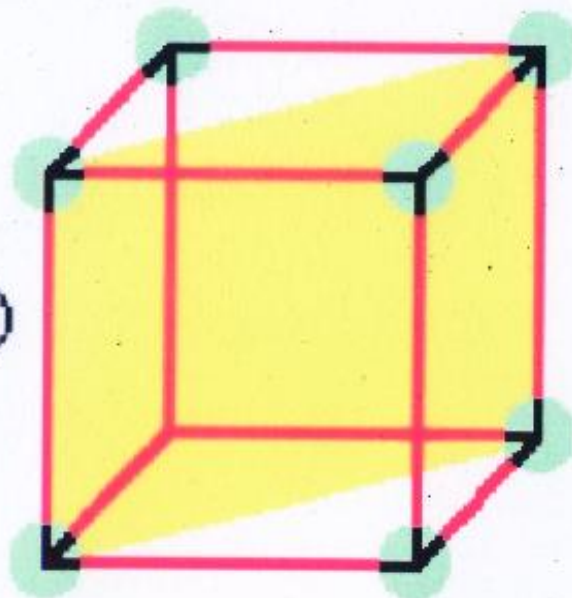
(100)



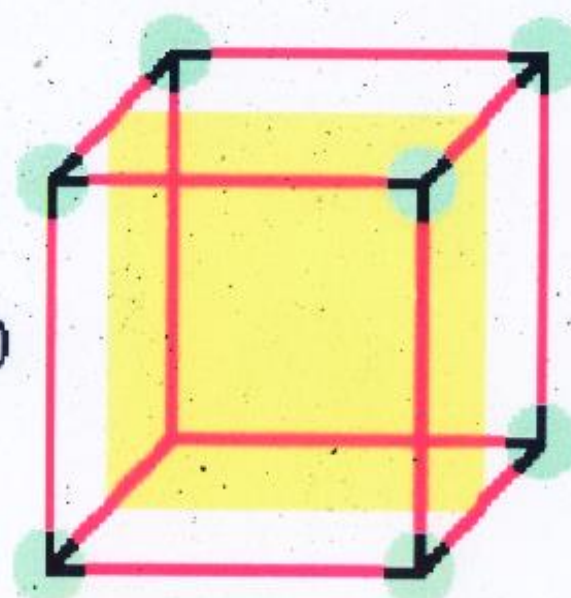
(111)



(110)



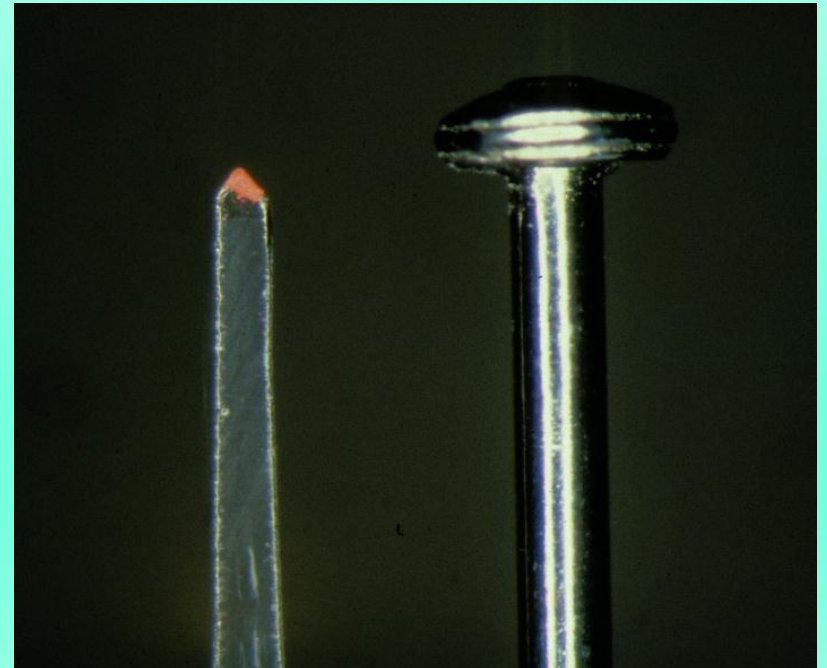
(200)

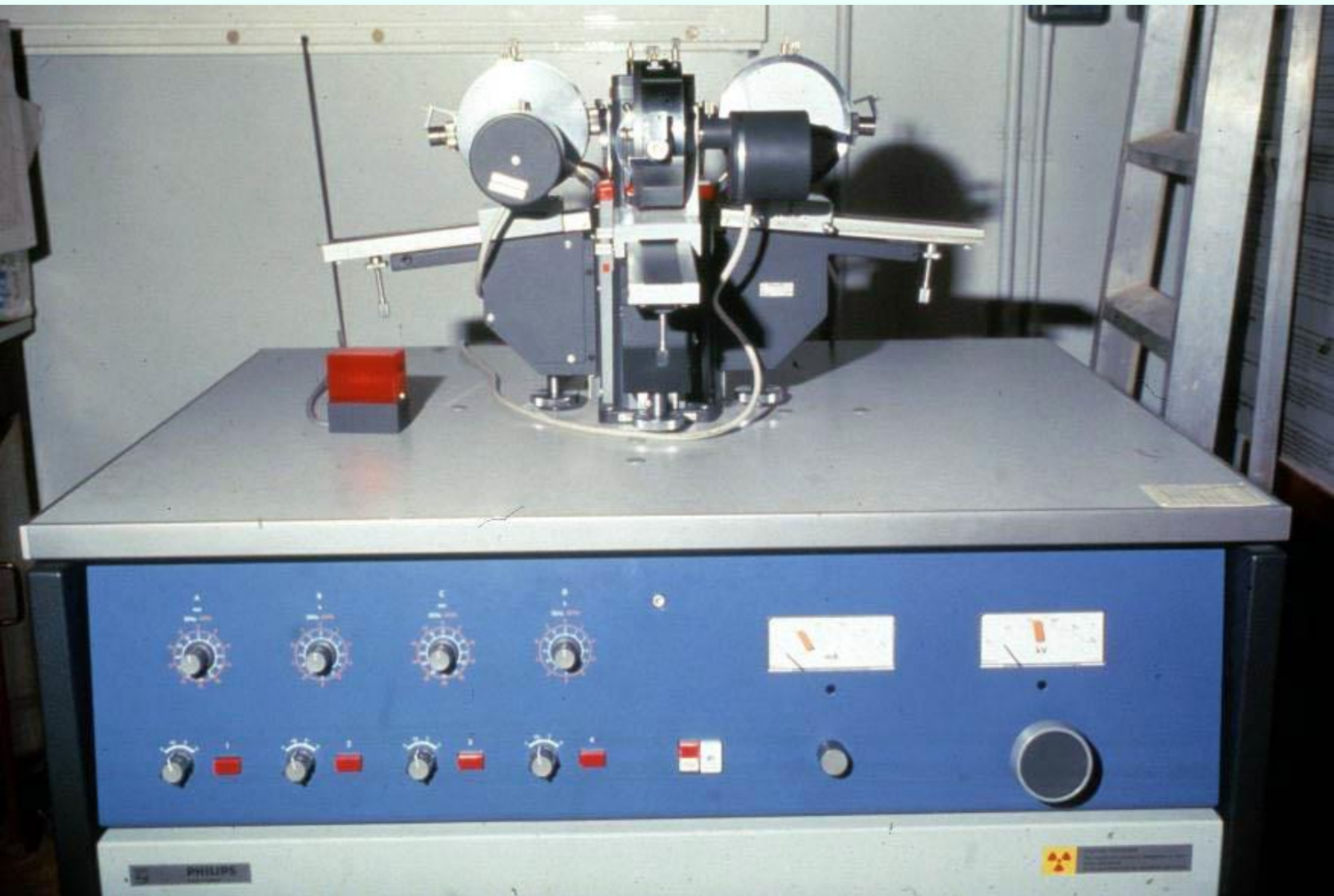


Métodos:

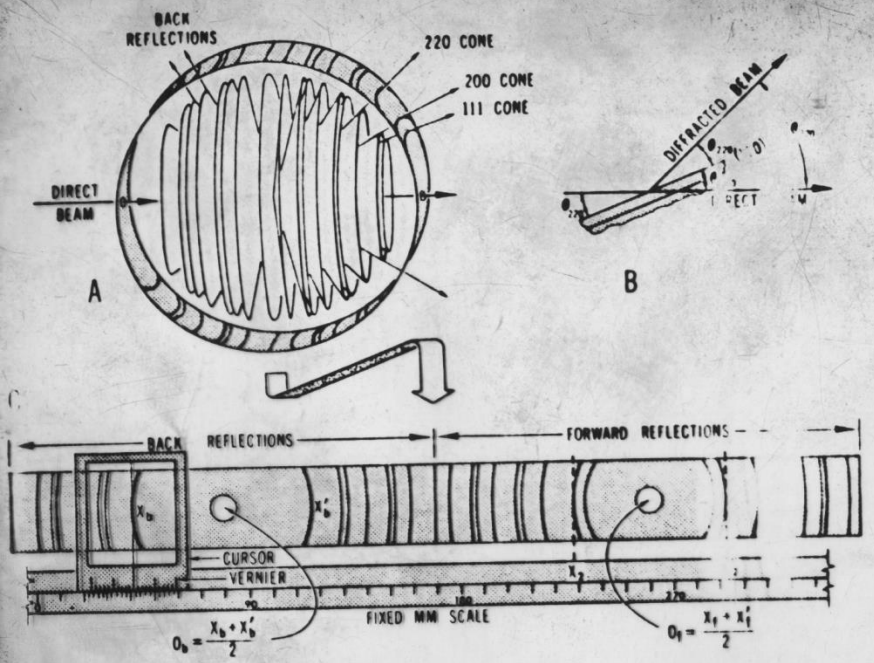
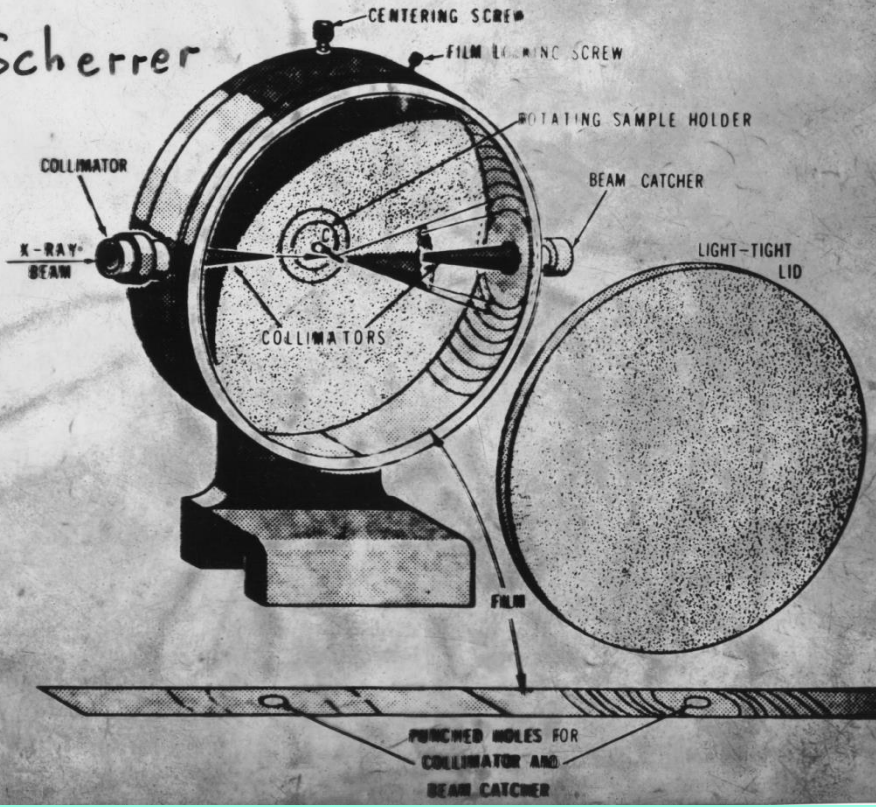
Pó:

Câmara Debye Scherrer





Scherrer



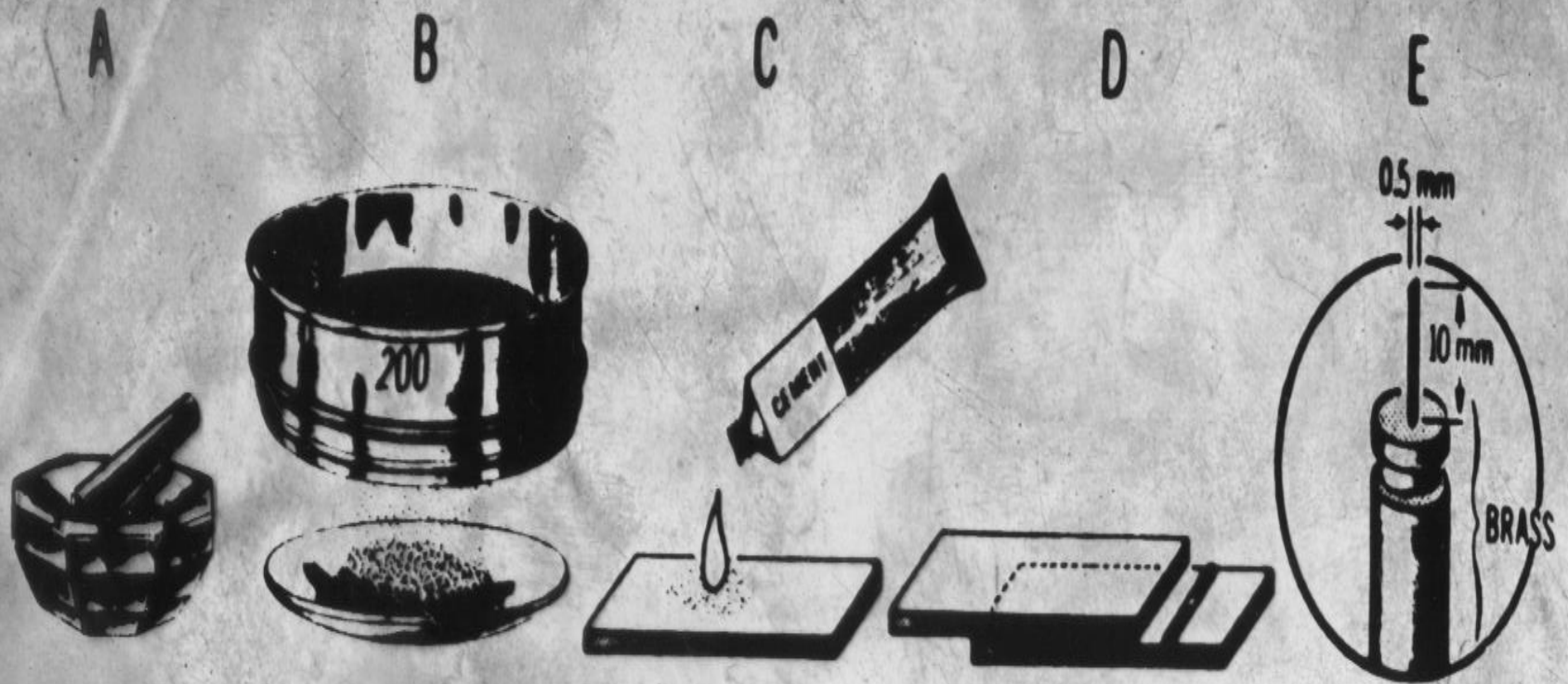
16371



16454



Preparação do material

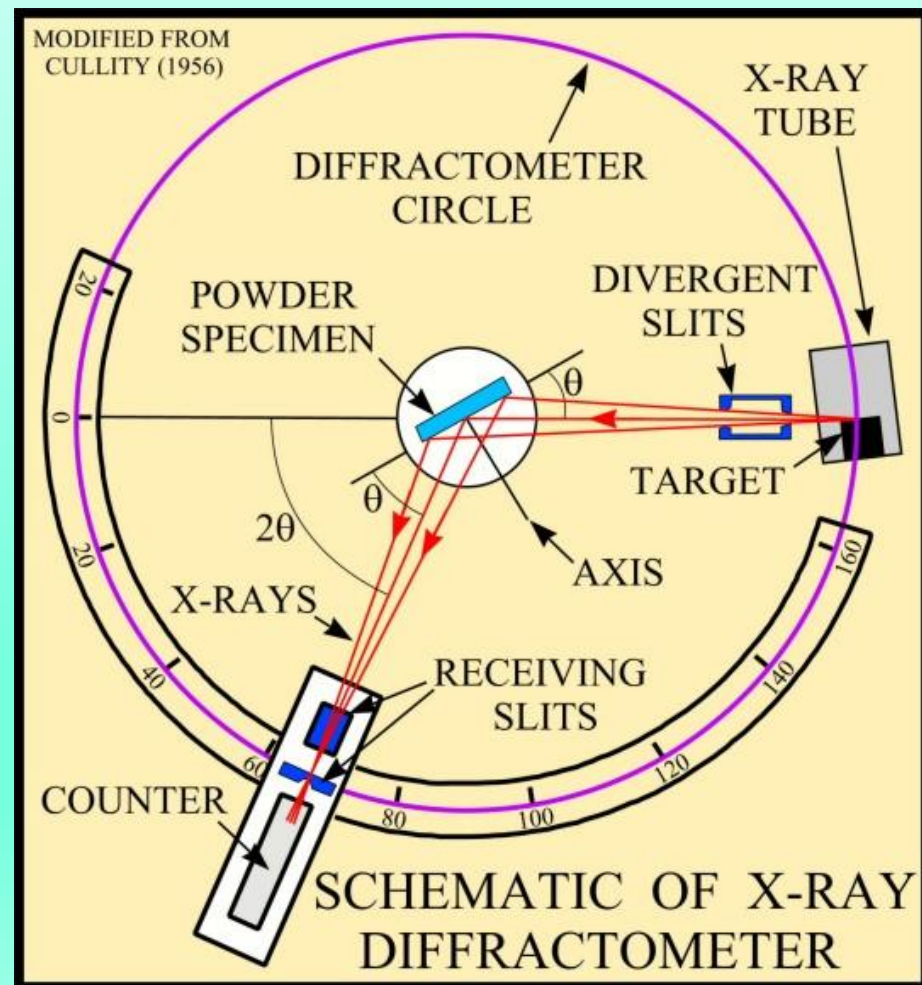
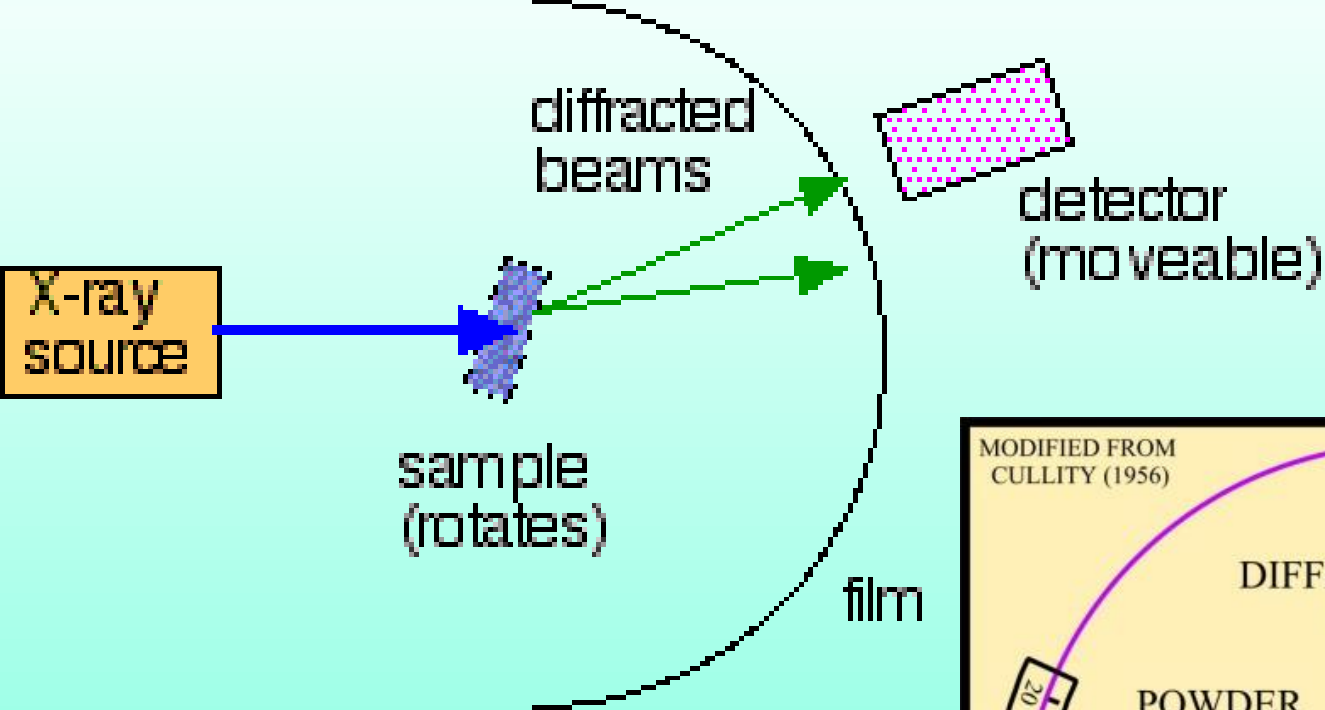


200 mesh ≈ 0.075 mm

Preparação do material:
pó prensado em lâmina.

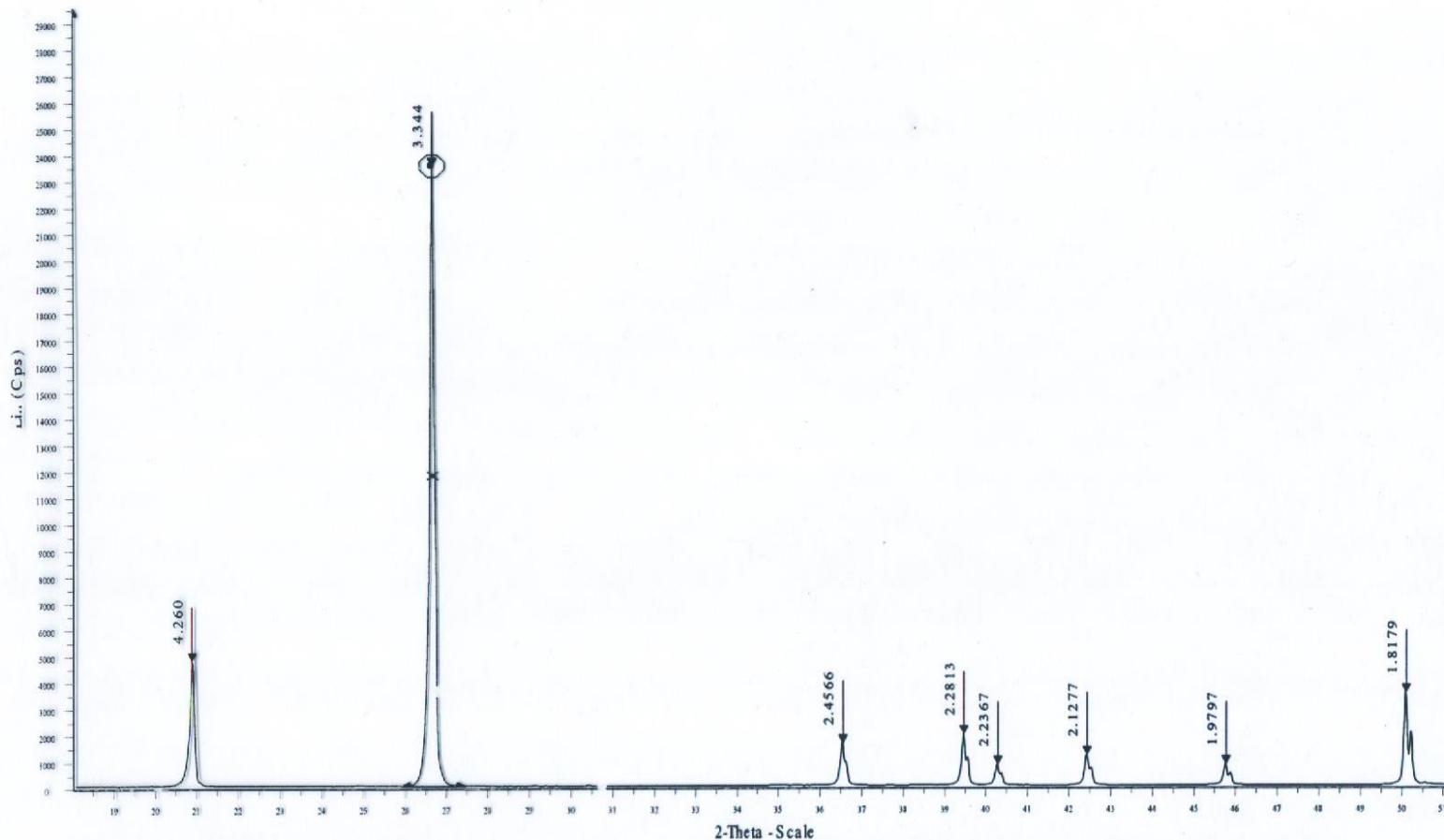
Difratômetro de raios X





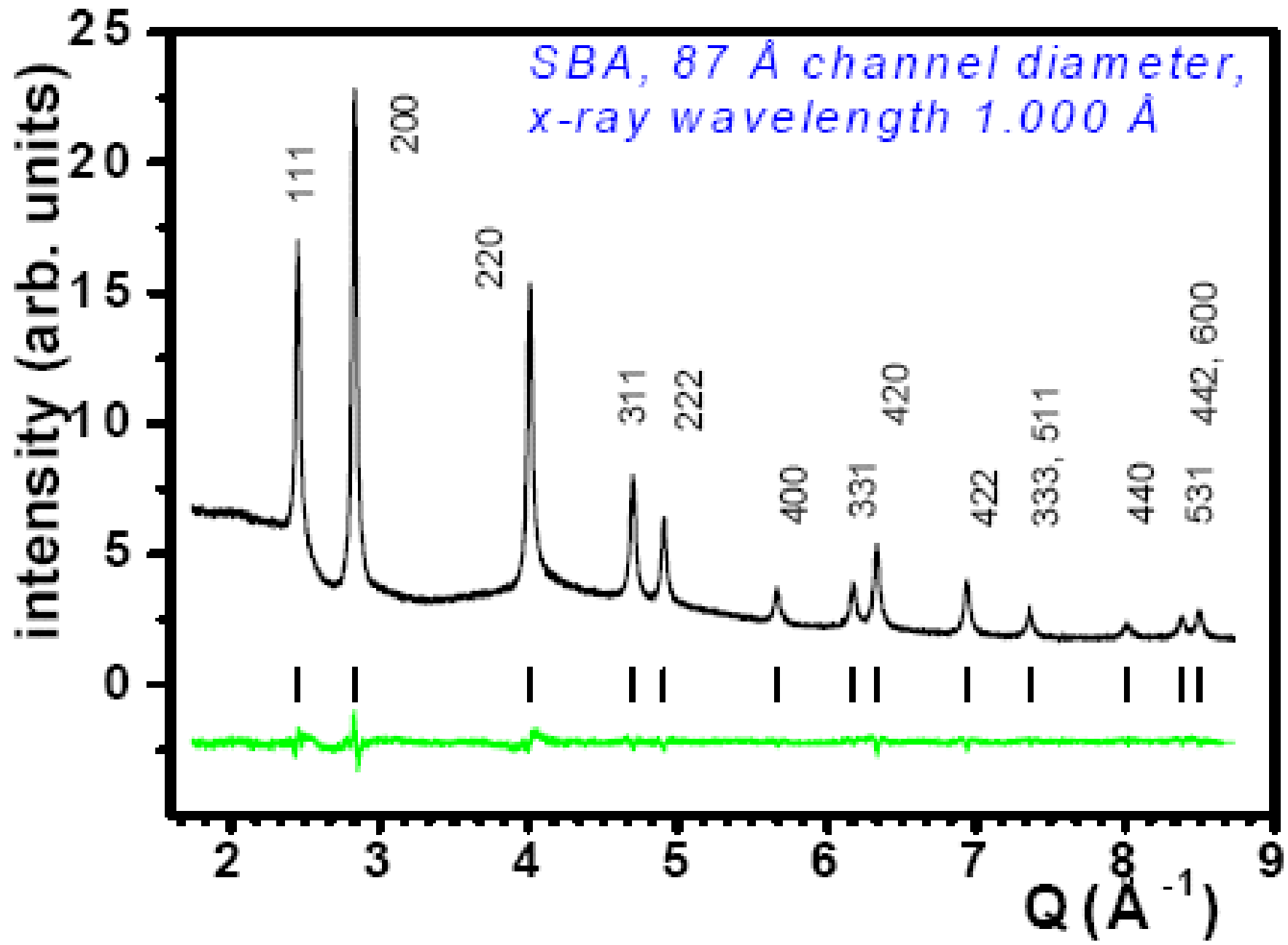
Difratograma de raios X

QUARTZ

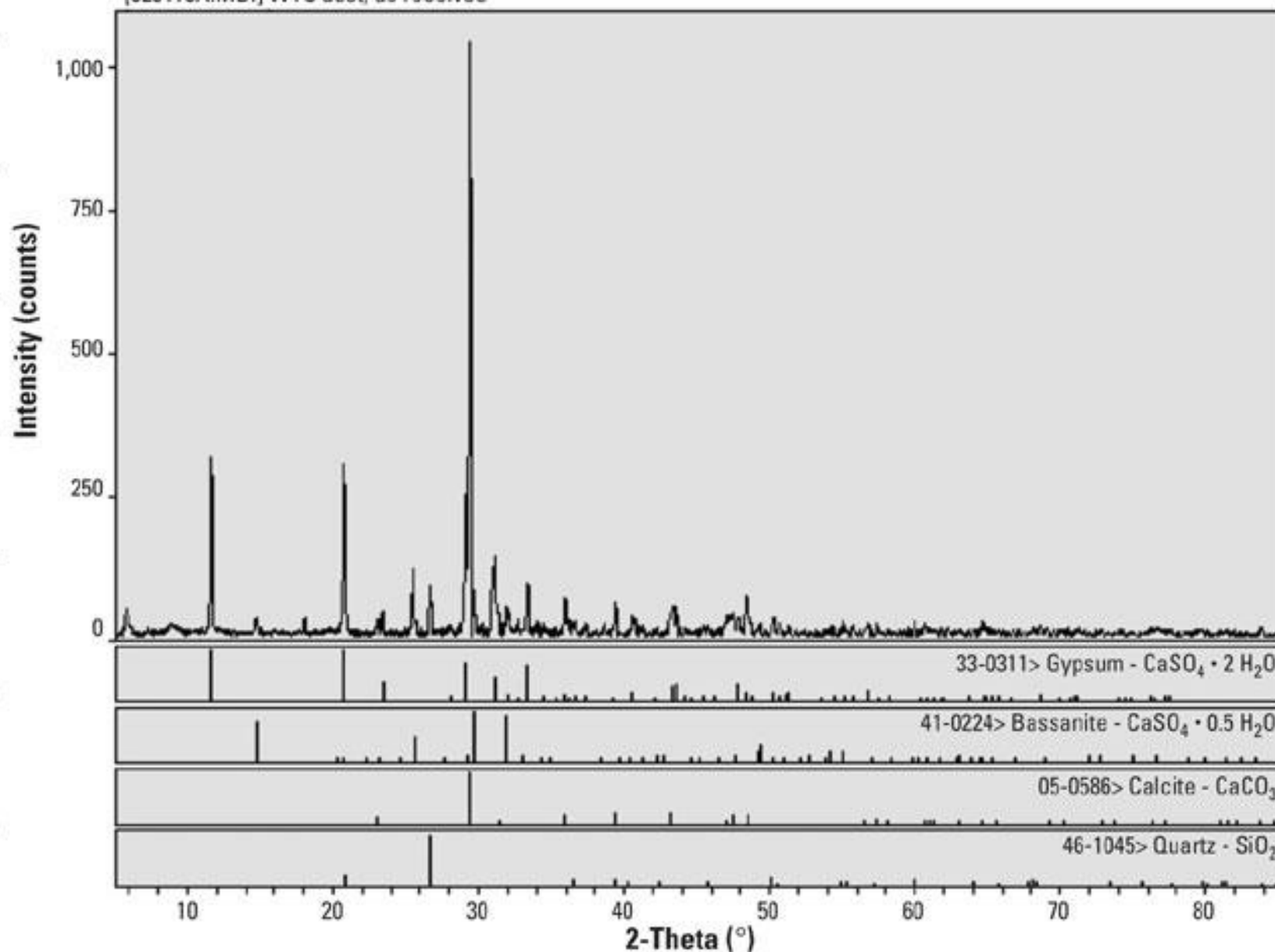


QUARTZ - File: Quartz.raw - Type: 2Th/Th locked - Start: 18.000 ° - End: 90.000 ° - Step: 0.020 ° - Step time: 10.0 s - Temp.: Room - Time Started: 0 s - 2-Theta: 18.000 ° - Theta: 9.000 ° - Chi: 0.0
1) QUARTZ - Left Angle: 25.880 ° - Right Angle: 27.440 ° - Left Int: 34.957 Cps - Right Int: 34.414 Cps - Obs. Max: 26.628 ° - d (Obs. Max): 3.345 - Max Int: 23625.912 Cps - Net Height: 23591.
Operations: Import

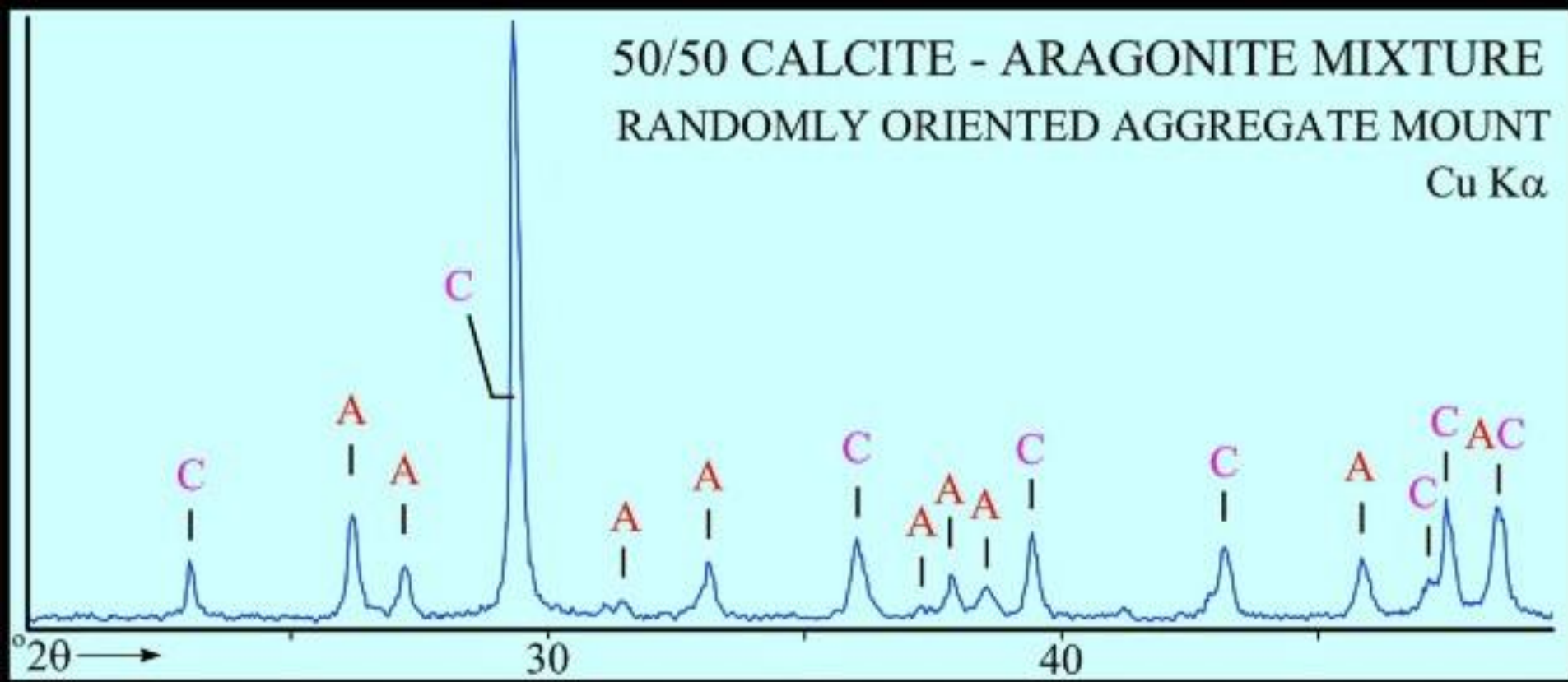
SBA, 87 Å channel diameter,
x-ray wavelength 1.000 Å



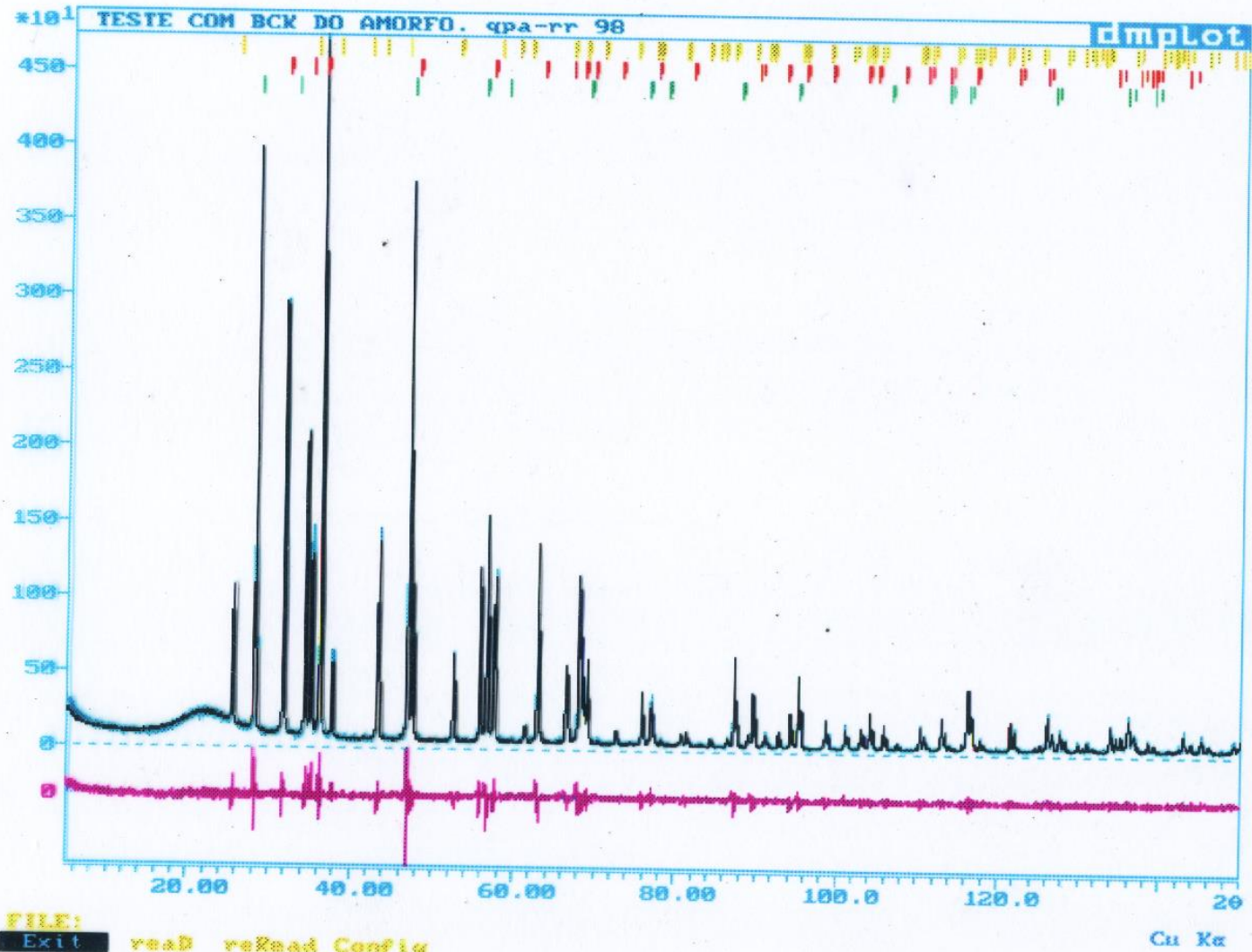
[020118A.MDI] WTC dust, as received



50/50 CALCITE - ARAGONITE MIXTURE
RANDOMLY ORIENTED AGGREGATE MOUNT
Cu K α



Resultado final da análise quantitativa de corindon, fluorita, zincita e um vidro



Lewisita

Hussak & Prior (1895)

$\text{CaSb}^{3+}_{2/3}(\text{Sb}^{5+}, \text{Ti}^{4+})_2\text{O}_6(\text{OH})$, com $\text{Sb}^{5+}:\text{Ti}^{4+} = 1:1$,
cúbico

Dados de difratometria de raios X para lewisita de
Tripuí, Ouro Preto, Minas Gerais.

Ficha 7-66

$d_{\text{obs.}}(\text{Å})$	$I_{\text{obs.}}(\%)$	$d_{\text{obs.}}(\text{Å})$	$I_{\text{obs.}}(\%)$	hkl	$d_{\text{calc.}}(\text{Å})$
5,794	7	5,84	20	111	5,953
3,069	9	3,08	30	311	3,109
2,9394	97	2,94	100	222	2,9765
2,5415	22	2,55	30	400	2,5777
2,3656	3			331	2,3655
1,9710	6	1,966	30	511	1,9844
1,8097	32	1,813	100	440	1,8227
1,7328	13	1,734	30	531	1,7429
1,5655	4			533	1,5724
1,5434	100	1,548	100	622	1,5544
1,4782	6	1,483	30	444	1,4883
1,4389	10	1,438	30	551	1,4438
1,3364	12	1,337	30	731	1,3424
1,2832	19	1,284	30	800	1,2889

a 10,311(7) Å, V 1096,23 Å³

Interpretação: JCPDS-ICDD

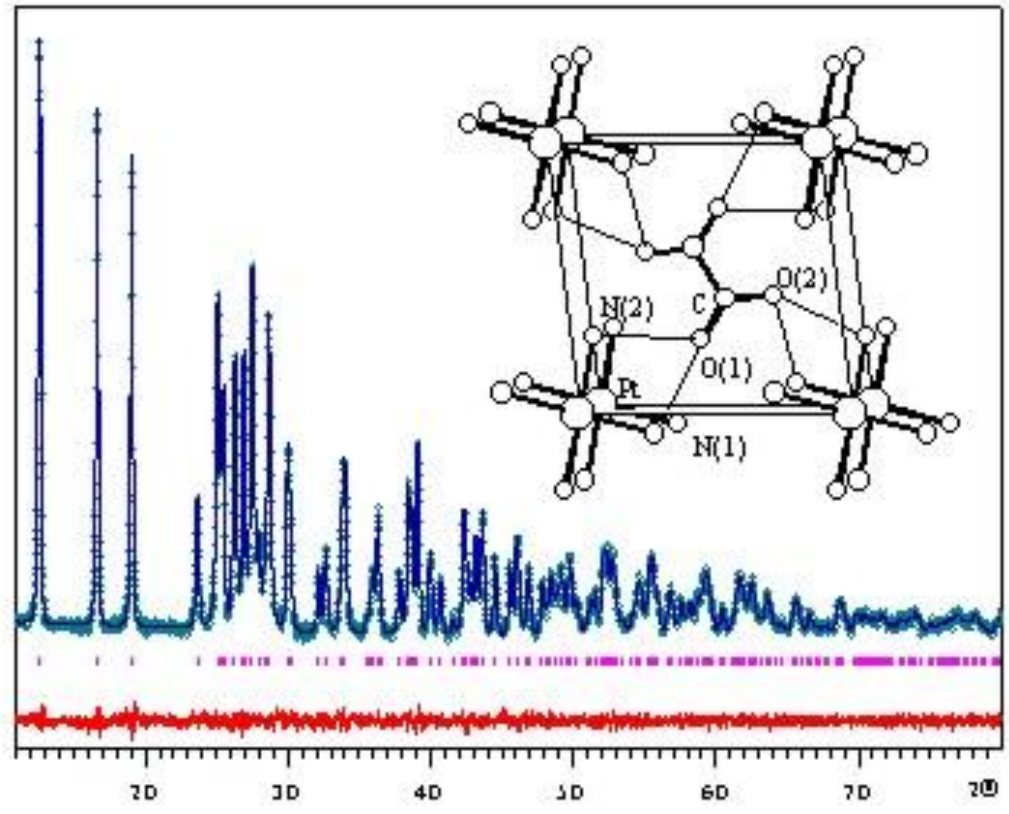
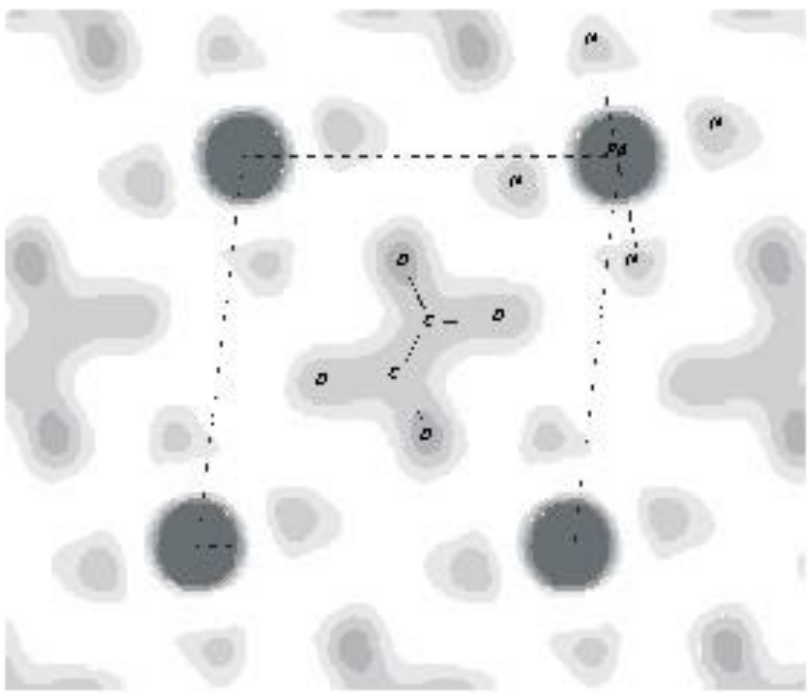
33-1161



SiO ₂	dÅ	Int	hkl	dÅ	Int	hkl
Silicon Oxide	4.257	22	100	1.1532	1	311
Quartz, syn	3.342	100	101	1.1405	<1	204
	2.457	8	110	1.1143	<1	303
	2.282	8	102	1.0813	2	312
	2.237	4	111	1.0635	<1	400
Rad. CuKα ₁ λ 1.540598 Filter Mono. d-sp Diff.	2.127	6	200	1.0476	1	105
Cut off Int. Diffractometer 1/λ _{cut} 3.6	1.9792	4	201	1.0438	<1	401
Ref. Natl. Bur. Stand. (U.S.) Monogr. 25, 18 61 (1981)	1.8179	14	112	1.0347	<1	214
Sys. Hexagonal S.G. P3 ₁ 21 (154)	1.8021	<1	003	1.0150	1	223
a 4.9133(2) b c 5.4053(4) A C 1.1001	1.6719	4	202	0.9898	1	402
α β γ Z 3 mp	1.6591	2	103	0.9873	1	313
Ref. Ibid.	1.6082	<1	210	0.9783	<1	304
D _x 2.65 D _m 2.66 SS/FOM F ₀₀ =77(013.31)	1.5418	9	211	0.9762	1	320
ca 1.544 cy 1.553 Sign + 2V	1.4536	1	113	0.9636	<1	205
Ref. Swanson, Fayat, Natl. Bur. Stand. (U.S.), Circ. 539, 3 24 (1954)	1.4189	<1	300			
Color Colorless	1.3820	6	212			
Pattern taken at 25 C. Sample from the Glass Section at NBS, Gaithersburg, Maryland, USA, ground single-crystals of optical quality. Pattern reviewed by Holzer, J., McCarthy, G., North Dakota State University, Fargo, North Dakota, USA, ICDD Grant-in-Aid (1990). Agrees well with experimental and calculated patterns. O ₂ Si type. Quartz group. Also called: silica. Also called: low quartz. Silicon used as internal standard. PSC: hP9. To replace 5-490 and validated by calculated pattern. Plus 6 additional reflections to 0.9089.	1.3752	7	203			
	1.3718	8	301			
	1.2880	2	104			
	1.2558	2	302			
	1.2285	1	220			
	1.1999	2	213			
	1.1978	1	221			
	1.1843	3	114			
	1.1804	3	310			

Determinação de estrutura cristalina





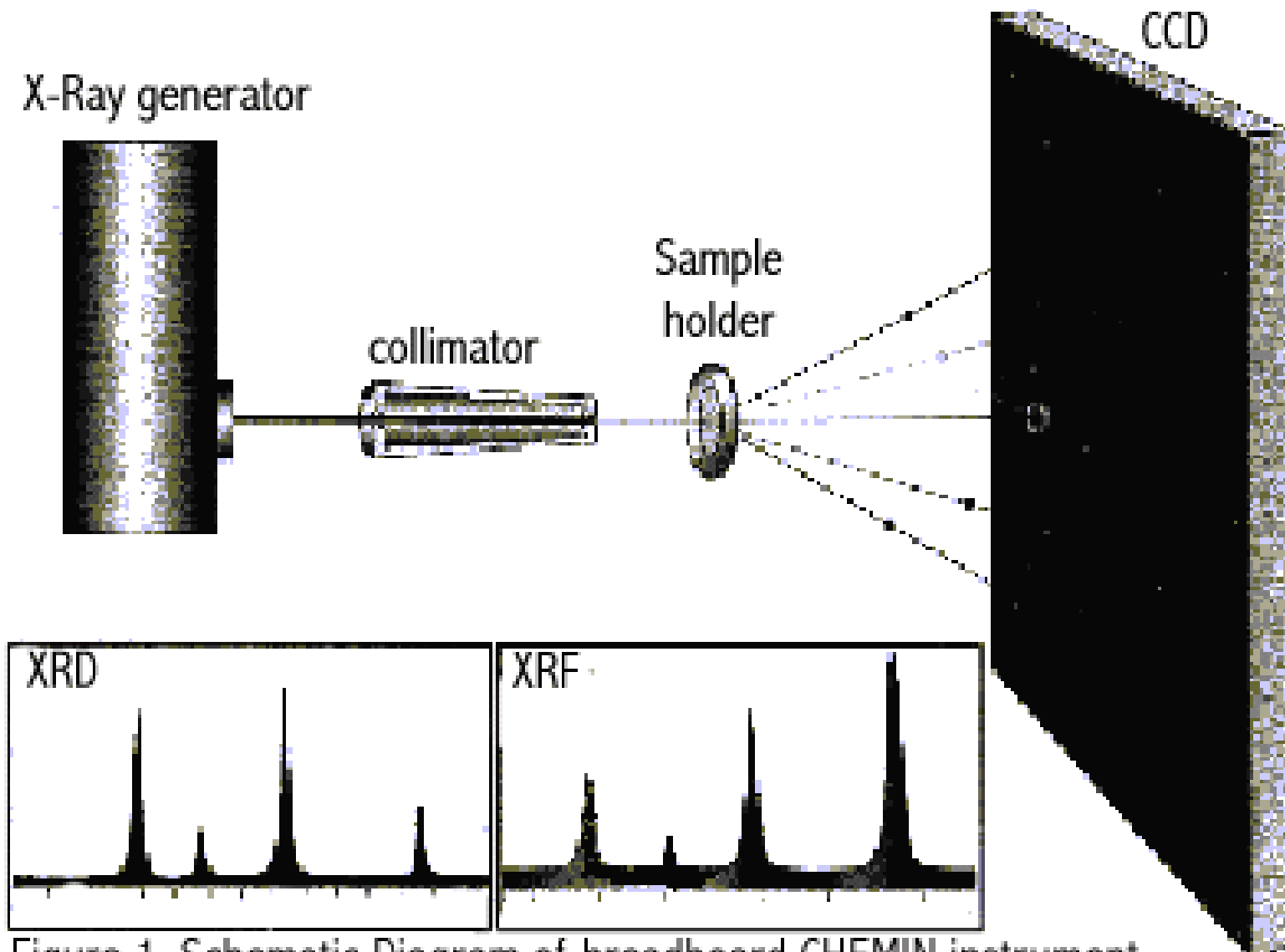


Figure 1. Schematic Diagram of breadboard CHEMIN instrument, showing simultaneous XRD/XRF data.

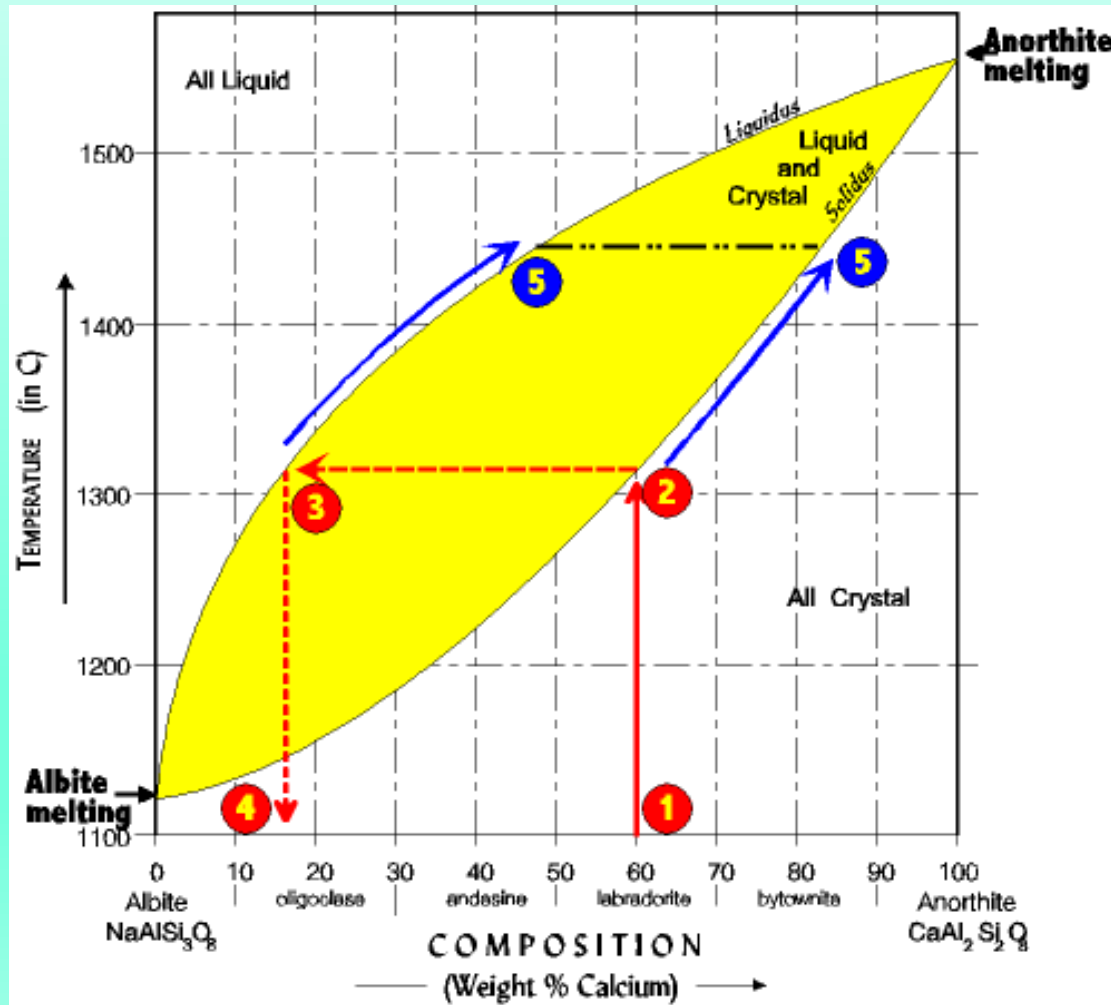
Principais aplicações:

- Determinação qualitativa de minerais;

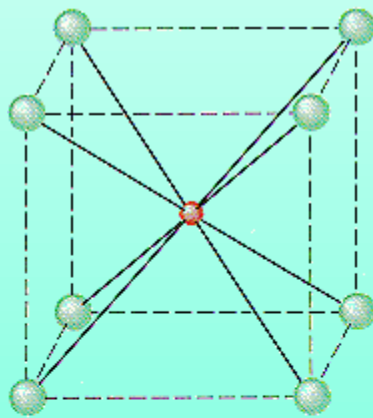


Determinação semi-quantitativa
(proporções relativas de minerais
numa amostra)

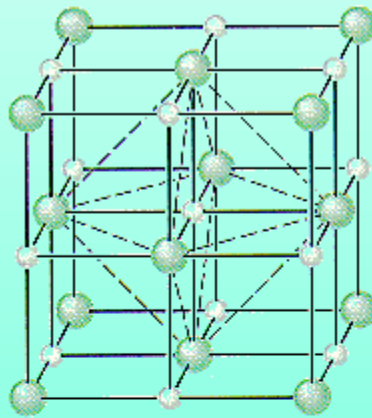
-Composição de séries isomorfas (plagioclásio, olivina, granada)



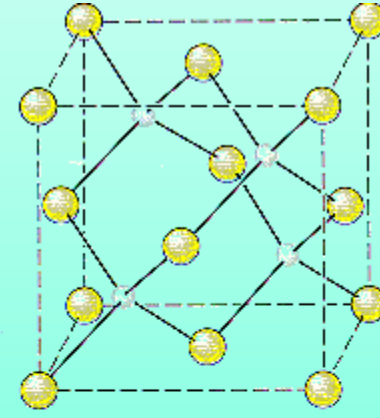
-Determinação estrutural (parâmetros de cela, grupos espaciais)



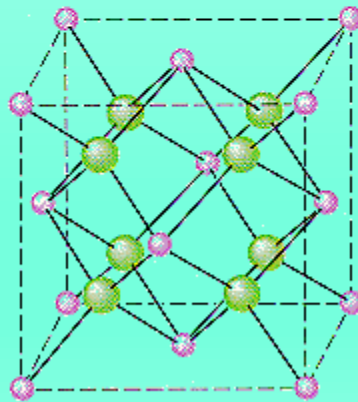
CsCl



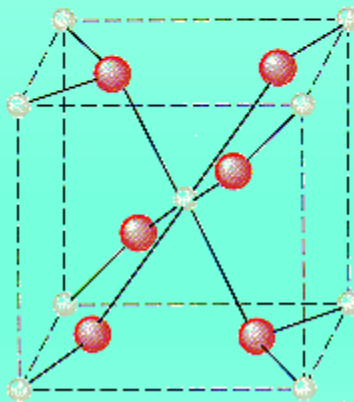
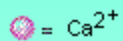
NaCl



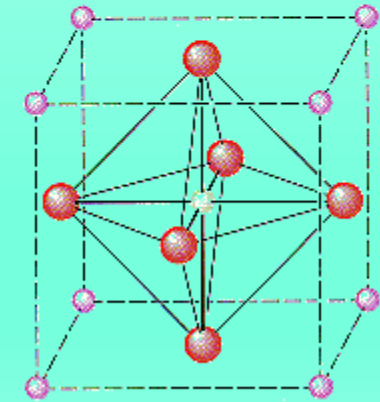
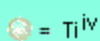
Zinc blende (cubic ZnS)



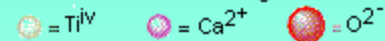
Fluorite (CaF₂)



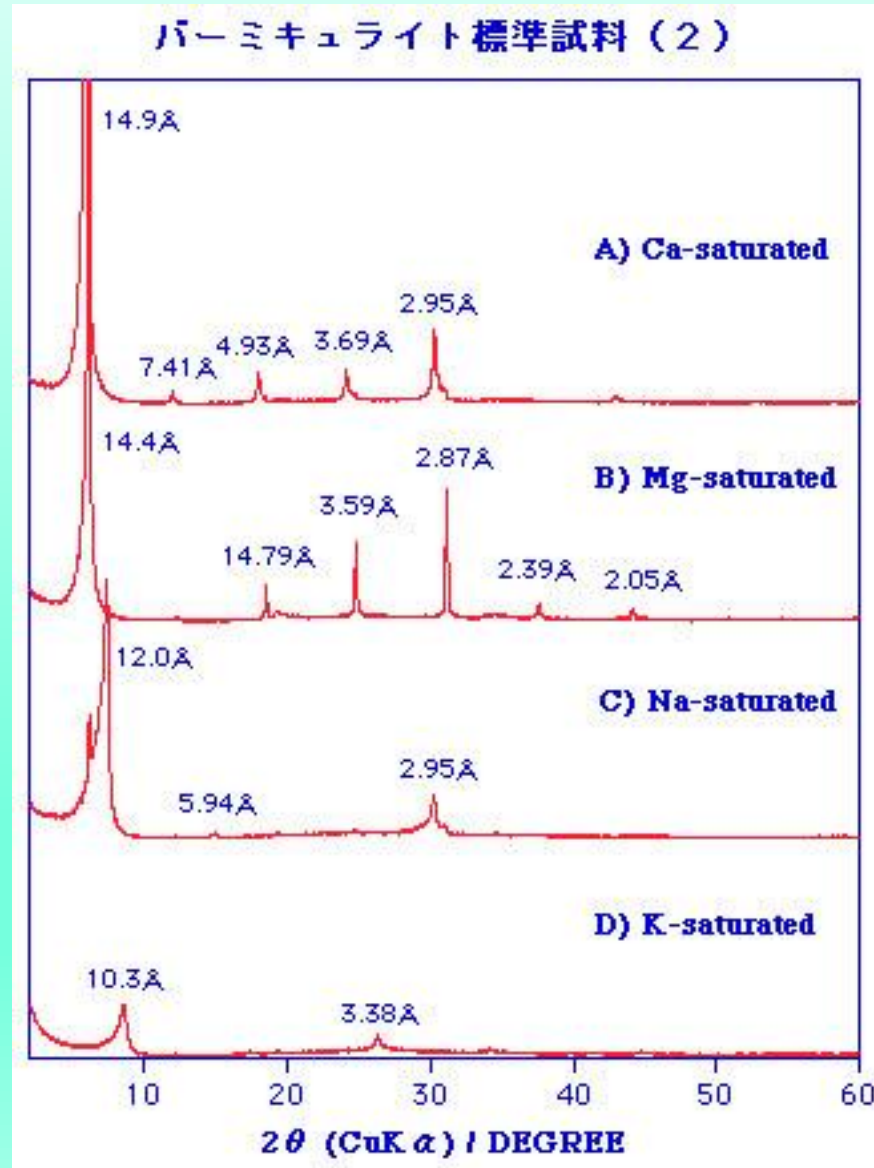
Rutile (TiO₂)



Perovskite (CaTiO₃)



-Estudo de filossilicatos



-Minerais de alteração





Cerâmica Marajoara



Difratometria de raios-x aplicada ao estudo preliminar da composição mineralógica de cerâmicas arqueológicas Marajoara

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RESUMO

A composição química dos minerais encontrados nas cerâmicas pode ser alterada pelo efeito da temperatura de queima. Tal fato pode ser bem evidenciado pelo estudo e observação das transições de fases cristalográficas dos minerais. Os compostos, freqüentemente encontrados, são quartzo, feldspato, mica, ilita, caulinita e outros minerais. Neste trabalho estudaram-se as possíveis diferenças na composição mineralógica das cerâmicas Marajoara. Para isso, amostras arqueológicas originais, cedidas pelo Museu de Arqueologia e Etnologia da USP, Museu do Marajó e contemporâneas foram analisadas por difração de raios-x. Os resultados mostraram que a composição mineralógica das cerâmicas arqueológicas e contemporâneas é similar, apresentando, principalmente, quartzo (Q). A ausência de outros tipos de minerais impede identificar se a cerâmica foi queimada em atmosfera oxidante ou redutora.

Muiraquitã

Muiraquitã é o nome dado pelos índios a pequenos amuletos trabalhados em forma de animal, geralmente representando sapos. São feitos de pedras de cor verde, ou de minerais como a nefrita.

REDAÇÃO

23/09/2020 16:05 | Atualizado 23/09/2020 16:06



O muiraquitã da estearia da Boca do Rio, Santa Helena, Maranhão: estudo arqueológico, mineralógico e simbólico

The muiraquitã of the Boca do Rio pile dwelling, Santa Helena, State of Maranhão: archaeological and mineralogical analysis

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Rômulo Simões Angélica^{II}, Suyanne Santos Rodrigues^{II}, João Costa Gouveia Neto^{IV}

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Resumo: O muiraquitã é um artefato arqueológico raro e característico das sociedades pré-coloniais do baixo Amazonas e de área circum-caribenha. Foi confeccionado por meio de diversos tipos de minerais, sendo os mais conhecidos os de pedra verde, sobretudo a nefrita. Embora sua função ainda seja desconhecida, a literatura etnográfica e arqueológica sugere que estes objetos conotavam símbolos de poder, haja vista a ampla rede de circulação em que estavam inseridos. Este artigo descreve um muiraquitã encontrado na estearia da Boca do Rio, região das estearias maranhenses. As análises foram feitas por MicroRaman, com auxílio do equipamento de bancada BWTEK, da GemExpert, difração de raios X (DRX), evidenciando que o artefato foi confeccionado em tremolita/actinolita, um mineral inexistente no Maranhão. Propõe-se uma possibilidade acerca da cadeia operatória do artefato e analisam-se as possíveis redes regionais de interação comercial e simbólica nas quais este muiraquitã esteve envolvido.

Palavras-chave: Muiraquitã. Estearias. Arqueologia da Amazônia. Difração de raio X. Análise por MicroRaman.

Caracterização arqueométrica de pinturas rupestres pré-históricas, pigmentos minerais naturais e eflorescências salinas de sítios arqueológicos

Luis Carlos Duarte Cavalcante

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Tese de Doutorado

Programa de Pós-Graduação em Química

Universidade Federal de Minas Gerais

Belo Horizonte (MG) 2012



O presente trabalho experimental foi dedicado à caracterização química e mineralógica de pinturas rupestres pré-históricas, de pigmentos minerais e de eflorescências salinas de sítios arqueológicos localizados nos estados do Piauí, Bahia e Ceará, no Brasil, e no Parque Nacional Perito Moreno, na Argentina. Amostras foram investigadas no laboratório por diversas técnicas analíticas, incluindo (i) espectroscopia Mössbauer de elétrons de conversão e transmissão do ^{57}Fe ; (ii) difração de raios X em incidência rasante; (iii) espectroscopia de energia dispersiva; (iv) microscopia eletrônica de varredura; (v) difração de raios X do pó; (vi) fluorescência de raios X por dispersão de energia e (vii) espectroscopia no infravermelho com transformada de Fourier. Os resultados revelaram que as pinturas vermelhas foram basicamente preparadas com materiais ricos em hematita ($\alpha\text{Fe}_2\text{O}_3$); as pinturas amarelas continham goethita (αFeOOH); as pinturas pretas eram essencialmente compostas por carbono, presumivelmente de carvão vegetal (exceto a amostra PCI-03, que continha carbono juntamente com hematita), e a pintura cinza foi preparada com uma mistura de



Os **fitólitos** são estruturas microscópicas rígidas feitas de sílica, encontradas em alguns tecidos da planta e persistindo após a decomposição da planta. Essas plantas retiram a sílica do solo, após o que são depositadas em diferentes estruturas intracelulares e extracelulares da planta.



Taxonomic Demarcation of *Setaria pumila* (Poir.) Roem. & Schult., *S. verticillata* (L.) P. Beauv., and *S. viridis* (L.) P. Beauv. (Cenchrinae, Paniceae, Panicoideae, Poaceae) From Phytolith Signatures

Mudassir A. Bhat, Sheikh A. Shakoor, Priya Badgal and Amarjit S. Soodan*

Plant Systematics and Biodiversity Laboratory, Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar, India

OPEN ACCESS

Background and Aims: The role and significance of phytoliths in taxonomic diagnosis of grass species has been well documented with a focus on the types found in foliar epidermis and the synflorescence. The present paper is an attempt to broaden the scope of phytoliths in species diagnosis of grasses by developing phytolith signatures

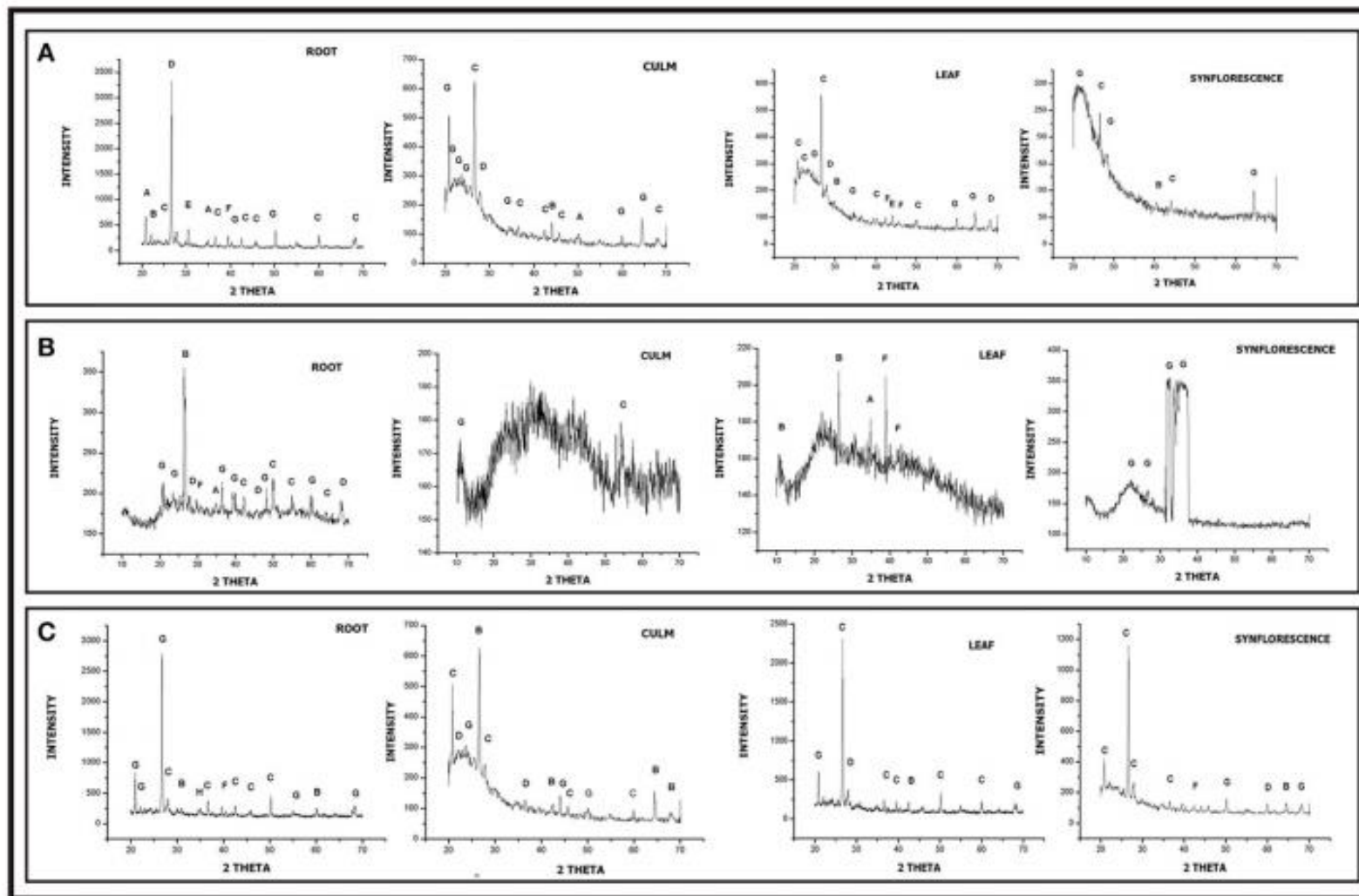


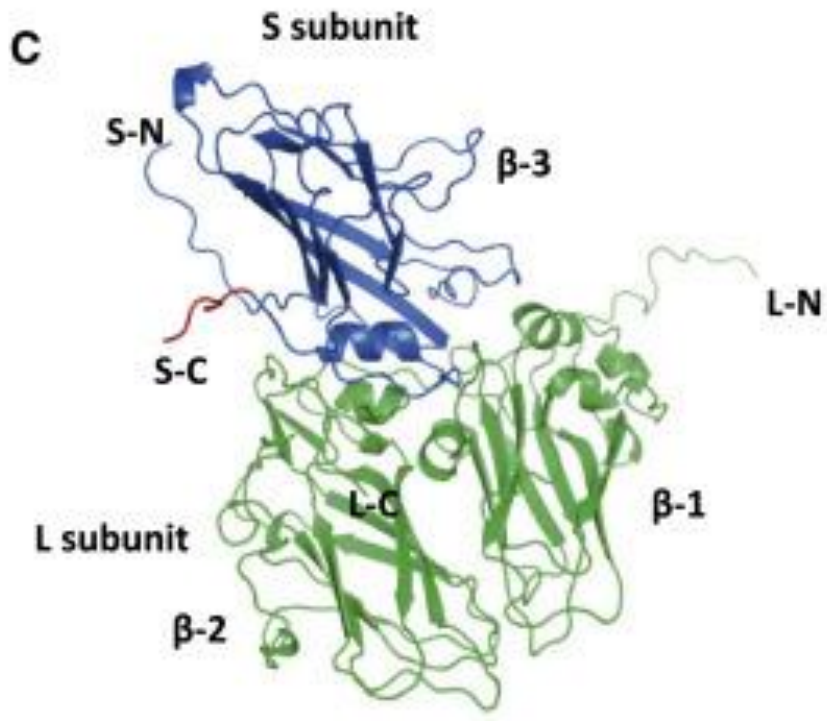
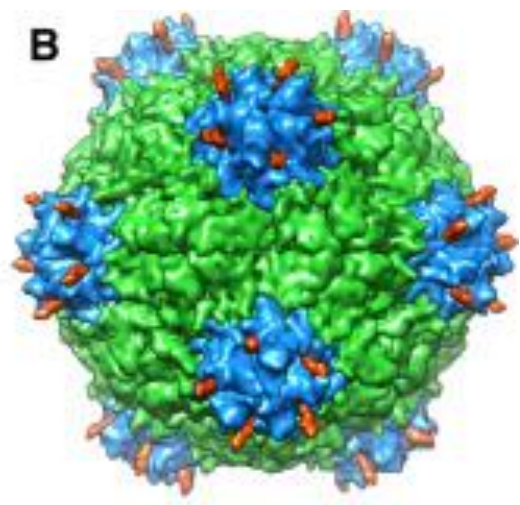
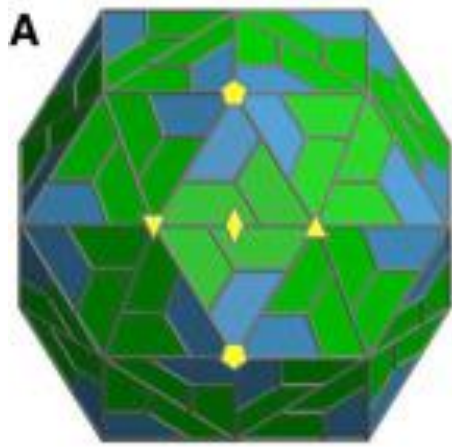
FIGURE 13 | XRD diffraction spectra of phytoliths isolated from different parts of *Setaria* spp. (A) *Setaria pumila* (B) *Setaria verticillata* (C) *Setaria viridis* (for description of peak points, refer to Supplementary Table 8).

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Scientists announce high-resolution crystal structure of new coronavirus 3CL hydrolysis enzyme

January 26, 2020

Following the January 25th, the Joint Emergency Response Team on The Infection of The New Coronavirus (2019-nCoV) of Shanghai University of Science and Technology and the Shanghai Institute of Medicine of the Chinese Academy of Sciences announced 30 possible anti-2019-nCoV coronavirus and Chinese medicine. The joint research team today further announced the high-resolution crystal structure of the 2019-nCoV coronavirus 3CL hydrolysis.






中国青年报  

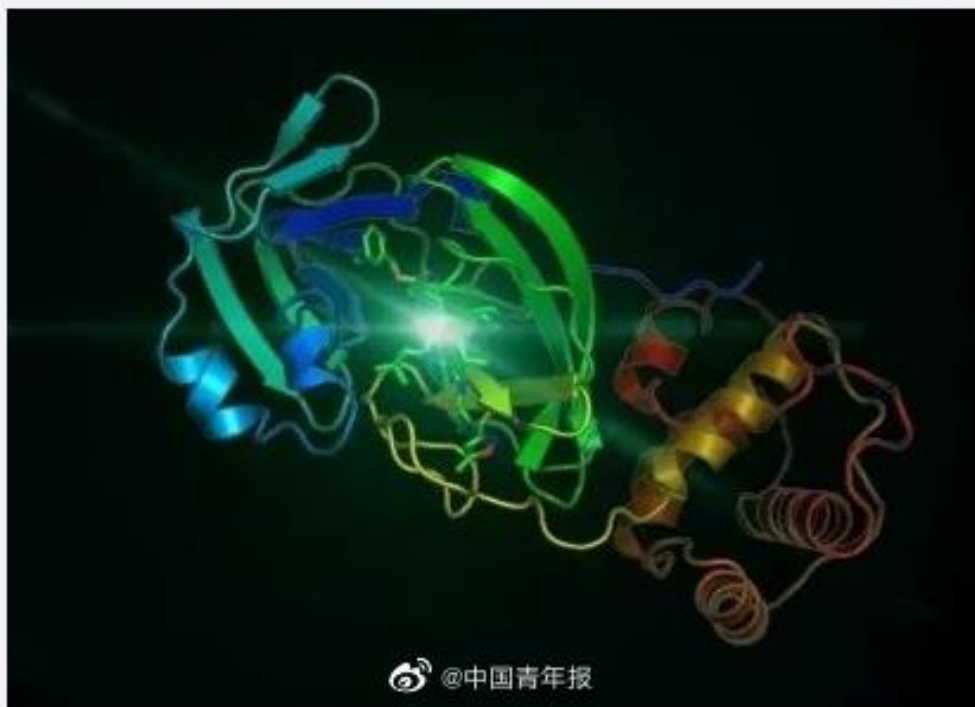
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[#科学家公布新型冠状病毒晶体结构#](#)【刚刚，科学家公布新型冠状病毒3CL水解酶高分辨率晶体结构】继1月25日上海科技大学免疫化学研究所和中国科学院上海药物研究所抗新型冠状病毒（2019-nCoV）感染联合应急攻关团队公布30个可能的抗2019-nCoV冠状病毒老药和中药后，这一联合攻关团队于今天进一步公布2019-nCoV冠状病毒3CL水解酶的高分率晶体结构。（中青报·中青网记者 邱晨辉）  刚刚，科学家公布新型冠状病毒3CL水解酶高分...

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 @中国青年报

Crystal Structure of the Receptor-Binding Domain from Newly Emerged Middle East Respiratory Syndrome Coronavirus

Yaoqing Chen,^a Kanagalaghatta R. Rajashankar,^b Yang Yang,^a Sudhakar S. Agnihothram,^c Chang Liu,^a Yi-Lun Lin,^a Ralph S. Baric,^c Fang Li^a

Department of Pharmacology, University of Minnesota Medical School, Minneapolis, Minnesota, USA^a; Department of Chemistry and Chemical Biology, Cornell University, NE-CAT, Advanced Photon Source, Argonne, Illinois, USA^b; Department of Epidemiology, University of North Carolina, Chapel Hill, North Carolina, USA^c

The newly emerged Middle East respiratory syndrome coronavirus (MERS-CoV) has infected at least 77 people, with a fatality rate of more than 50%. Alarming, the virus demonstrates the capability of human-to-human transmission, raising the possibility of global spread and endangering world health and economy. Here we have identified the receptor-binding domain (RBD) from the MERS-CoV spike protein and determined its crystal structure. This study also presents a structural comparison of MERS-CoV RBD with other coronavirus RBDs, successfully positioning MERS-CoV on the landscape of coronavirus evolution and providing insights into receptor binding by MERS-CoV. Furthermore, we found that MERS-CoV RBD functions as an effective entry inhibitor of MERS-CoV. The identified MERS-CoV RBD may also serve as a potential candidate for MERS-CoV subunit vaccines. Overall, this study enhances our understanding of the evolution of coronavirus RBDs, provides insights into receptor recognition by MERS-CoV, and may help control the transmission of MERS-CoV in humans.

Since the summer of 2012, a novel coronavirus, Middle East respiratory syndrome coronavirus (MERS-CoV), has emerged from the Middle East and spread to parts of Europe. MERS-CoV infection often leads to acute pneumonia and renal failure, and the human fatality rate is more than 50% (1, 2). To date, MERS-CoV has infected at least 77 people and was able to be transmitted from human to human. The genomic sequence of MERS-CoV is closely related to the sequences of certain bat coronaviruses (3–5), raising concerns over persistent bat-to-human cross-species transmission of the virus. The clinical signs and epidemic patterns of

mains, an N-terminal domain (NTD) and a C-domain, both of which can potentially function as receptor-binding domains (RBD) (Fig. 1A) (23). Specifically, coronavirus S1 C-domains can function as ACE2-, APN-, or heparan sulfate-binding RBDs, whereas S1 NTDs can function as CEACAM1- or sugar-binding RBDs. To date, crystal structures have been determined for a number of coronavirus RBDs by themselves or in complex with their host receptors, revealing how coronaviruses have evolved to recognize host receptors and thereby traffic between different species (24–28). It is not known which one of MERS-CoV S1 domains

TABLE 1 Data collection and refinement statistics

Parameter	MERS-RBD native ^a	NaI derivative ^a
Data collection		
Space group	P2 ₁ 2 ₁ 2 ₁	P2 ₁ 2 ₁ 2 ₁
Cell dimensions		
<i>a</i> , <i>b</i> , <i>c</i> (Å)	45.361, 108.065, 124.287	45.822, 108.817, 124.328
α , β , γ (°)	90, 90, 90	90, 90, 90
Resolution (Å)	50–2.13 (2.17–2.13)	50–2.32 (2.36–2.32)
<i>R</i> _{sym} or <i>R</i> _{merge}	0.065 (0.459)	0.119 (0.574)
<i>I</i> / σ <i>I</i>	31.8 (2.0)	18.3 (2.0)
Completeness (%)	97.8 (62.3)	98.5 (90.5)
Redundancy	6.9 (4.3)	4.3 (2.7)
Refinement		
Resolution (Å)	49.6–2.13	
No. of reflections	34770	
<i>R</i> _{work} / <i>R</i> _{free}	0.149/0.206	
No. of atoms	3,701	
Protein	3,261	
Ligand	120	
Water	320	
<i>B</i> factors (Å ²)	43.3	
Protein	40.1	
Ligand	104.3	
Water	53.1	
RMSD		
Bond lengths (Å)	0.008	
Bond angles (°)	1.33	

^a Values in parentheses are for the highest-resolution shell.

Coronavirus Crystals - Which Healing Crystals Are The Best For COVID-19?

by Perry Valentine • March 14, 2020

ATPERRYS HEALING CRYSTALS

CORONAVIRUS CRYSTALS

Which are the best crystals to avoid and cure Coronavirus?

Bibliografia: Bloss, Bunn, Dana,
Técnicas Analíticas...
Mais profundos: Buerger,
Azzaroff, Reviews in
Mineralogy.