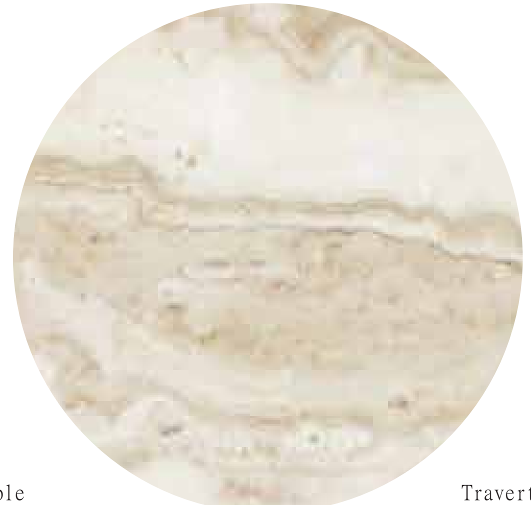
Build Like the Planet: Toward a Pegmatitic Architecture

Carrera Marble



Travertine

Noir Belge Marble

Griotte Marble

Limestone

[Is Stone] The Old World [?]

Lalibela

Petra, Jordean

Wells Cathedral

Victorian Cabinet of Curiosities

H. H. Richardson

Mise Van der Roe

Yes it is; The Death of Stone in Architecture

Niche//Pastiche//Simulation//Simulacra

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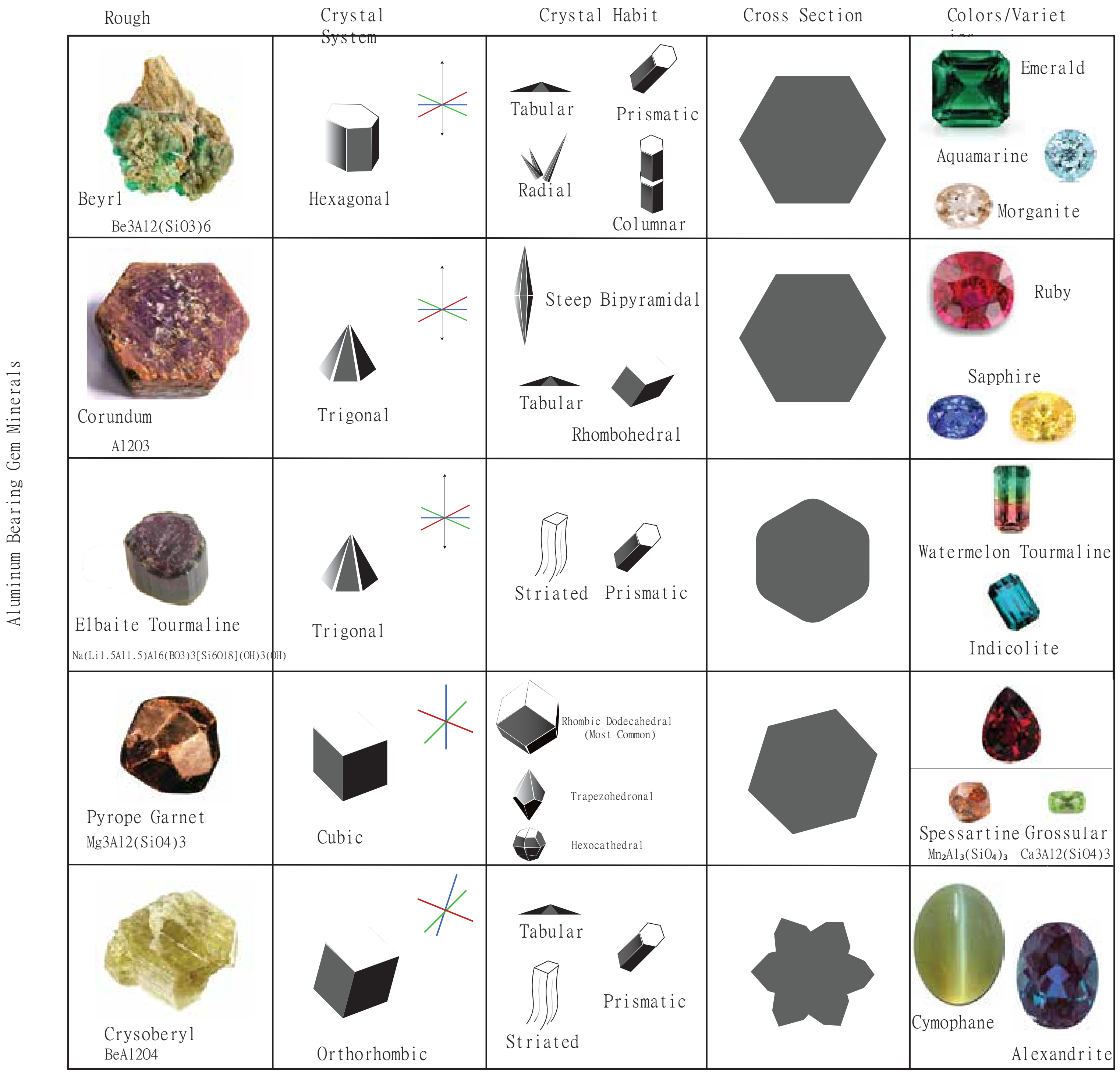
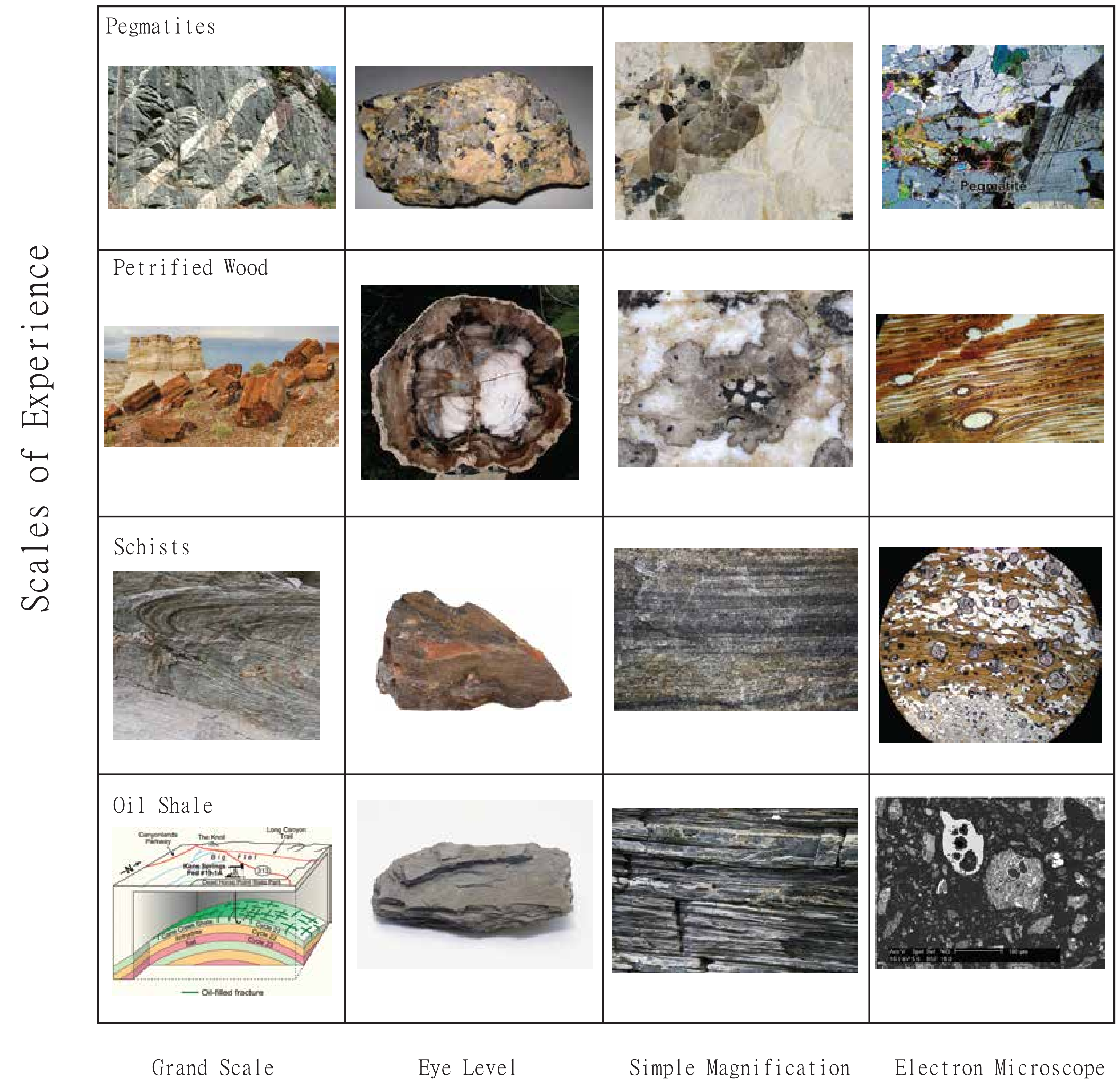
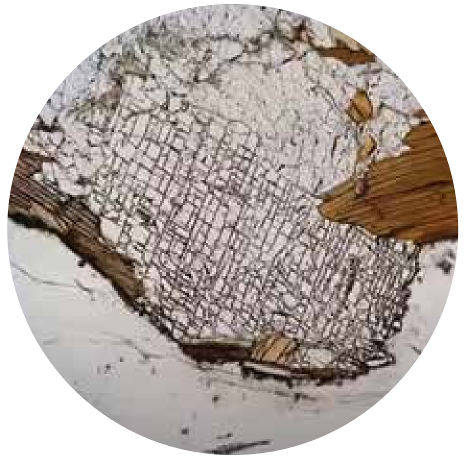


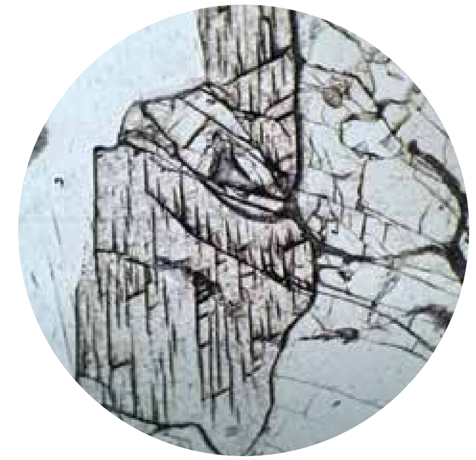
Aluminum Bearing Gem Minerals
Rough
Crystal System
Crystal Habit
Cross Section
Colors/Varieties
Beyrl
Be3Al2(Si03)6
Hexagonal
Tabular
Prismatic
Radial
Columnar
Emerald
Aquamarine
Morganite
Corundum
Al203
Trigonal
Steep Bipyramidal
Tabular
Rhombohedral
Ruby
Sapphire
Elbaite Tourmaline
Na(Li1.5Al1.5)Al6(BO3)3[Si6O18](OH)3(OH)
Trigonal
Striated
Prismatic
Watermelon Tourmaline
Indicolite
Pyrope Garnet
Mg3Al2(SiO4)3
Cubic
Rhombic Dodecahedral (Most Common)
Trapezohedronal
Hexocathedral
Spessartine
Grossular
Mn₂Al₃(SiO₄)₃
Ca3Al2(SiO4)3
Crysoberyl
BeAl2O4
Orthorhombic
Tabular
Prismatic
Striated
Cymophane
Alexandrite



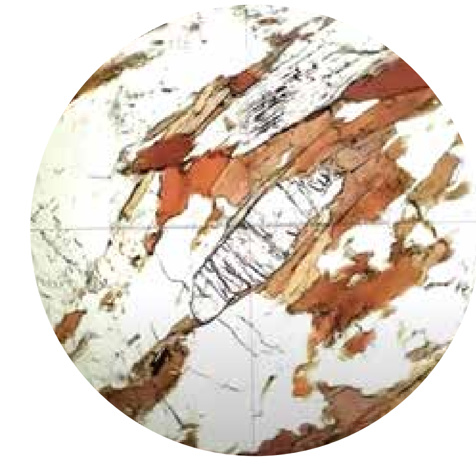
Scales of Experience
Pegmatites
Petrified Wood
Schists
Oil Shale
Grand Scale
Eye Level
Simple Magnification
Electron Microscope



Feldspar, Can show cleavage planes



Kyanite, One good cleavage, one parting

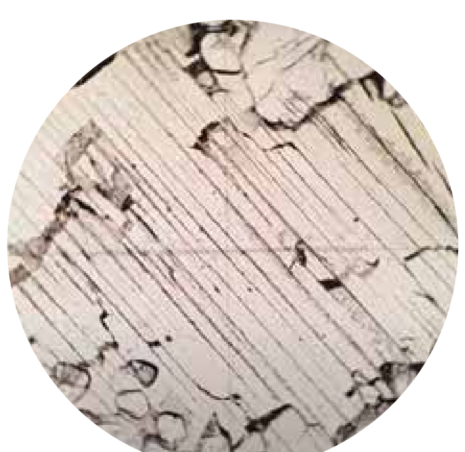


Apetite, Cross-fractures only

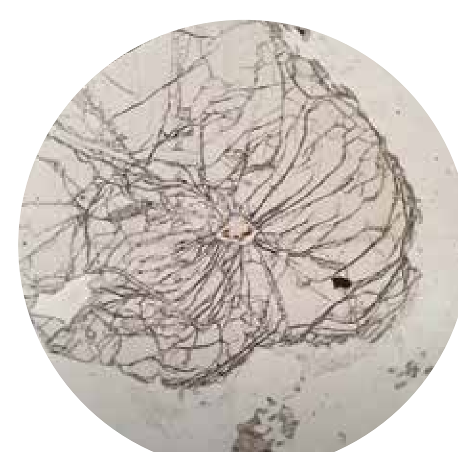
Cleavage Planes and Thin Section Analysis

Gedrite 60/120

Biotite, One Cleavage Plane



Clintonite (Mica), One Cleavage Plane



Garnet, No Cleavage, Can Fracture

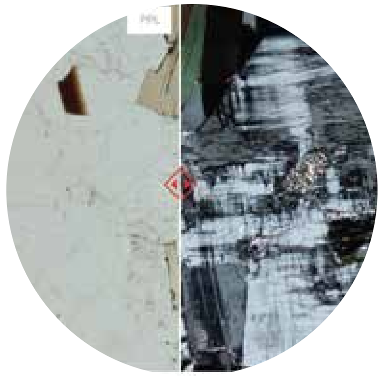
Clinopyroxene, 90/90

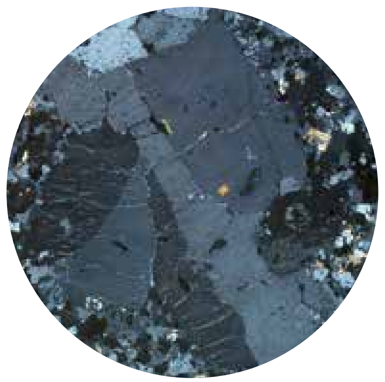
Pegmatites:

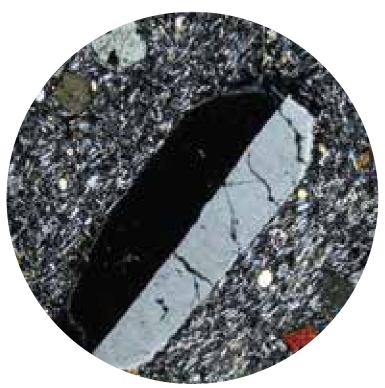
An **exceptionally coarse-grained igneous rock**, with interlocking crystals, usually found as **irregular dikes, lenses, or veins,** esp. at the margins of batholiths. Most grains are **1 cm or more in diameter**. Although pegmatites having gross compositions similar to other rock types are known, their composition is generally that of granite; the **composition may be simple or complex** and **may include rare minerals** rich in such elements as lithium, boron, fluorine, niobium, tantalum, uranium, and rare earths. Pegmatites represent the last and most hydrous portion of a magma to crystallize and hence contain high concentrations of minerals present only in trace amounts in granitic rocks. Adj: **pegmatitic**.

-Mindat.org

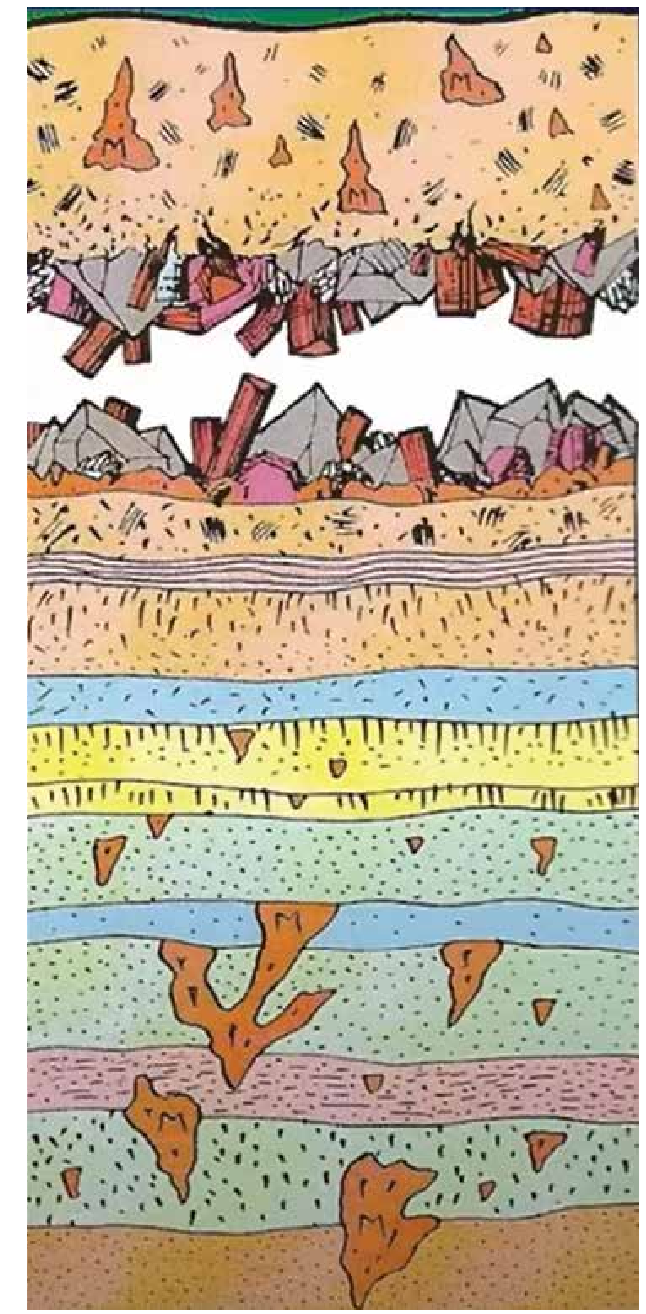
"Isn't this just Granite???"







Not Exactly



The word [**pegmatite**] comes **from the Greek [pegnym] meaning is to bind together** and this is in reference to this in growth of quartz crystals and feldspar crystals... many of us think of pegmatites as a rock but in the very strictest sense of the word it's actually a textural terms that describes ous rocks that are coarse grain to gigantic grain size

Now in terms of their composition their minerological composition that is you can have **granitic pegmatite**s, granodioritic ones tonalitic all the way to the gabbroic and syenitic, but it's the **granitic** ones that are the most common in the Earth's crust and these are the ones that we tend to gravitate towards as **mineral collectors and research scientists** some of the features of granite pegmatites include lucracratitic or what we referred to as light color ... the minerals are uniformly distributed in a homogeneous pegmatite or we may see **layered or zone features** within heterogeneous or Zone pegmatites. Also in these pegmatites some of these textures can be extremely variable ..There are **nearly 500 different mineral species** that we know of that can occur from pegmatites

Michael Wise PhD, Smithsonian NMNH

Grow Large, Cool Slow

Bitoite Mica

Quartz

Ametrine

Ferruginous Quartz

Alkali-Feldspar

Microcline

Orthoclase

Granite Pegmatites: Primary Ingredients

Critical Question:
"What do we crush?" "Trading the matrix for the jewels?"

Precious and Semi-Precious Stones

Rare Earth Minerals

Zircon

Cassiterite

Garnet Family

Anatase

TiO_2 (Titanium Dioxide)

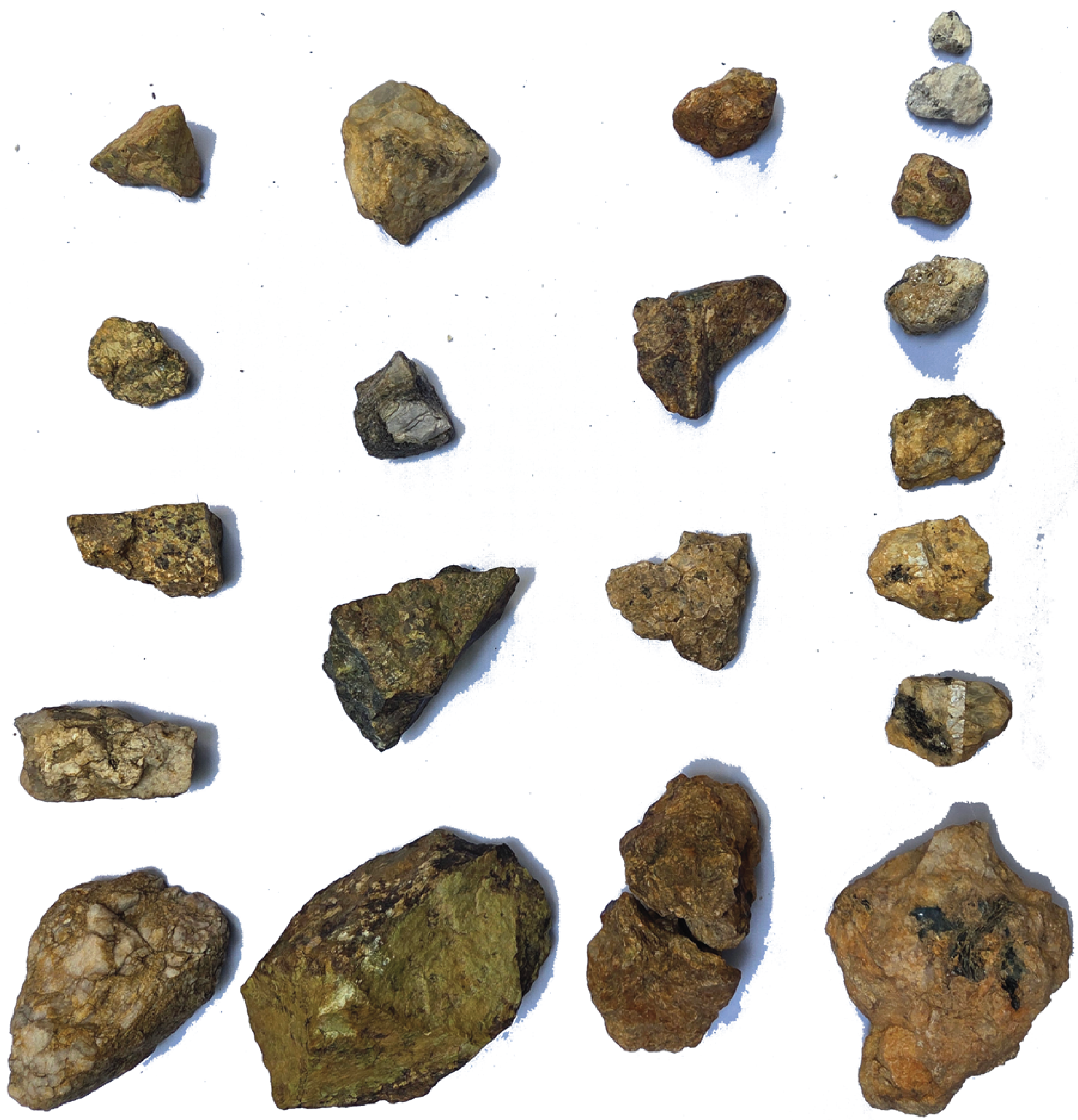
Lithium

Rubelite

Hiddenite

Rutile

A Forest of Trees: The Fruits of Incompatible Elements



Because this species is by nature variable, and thus defined by its components and their mixture, pegmatites are not rocks in the "monolithic" sense, and can best be understood as a **series of conditions and systematic expressions** of the geologic reactions and compositions specific to their formation. In this way, most specifically, do the poetics of architecture and coincide.

Pegmatites and architecture are similar in the sense that they are both tangible things as much as they are phenomena. The gemstones they produce are attractive in their own right, but to the knowledgeable observer, less spectacular than the many forces and processes that comprise them.

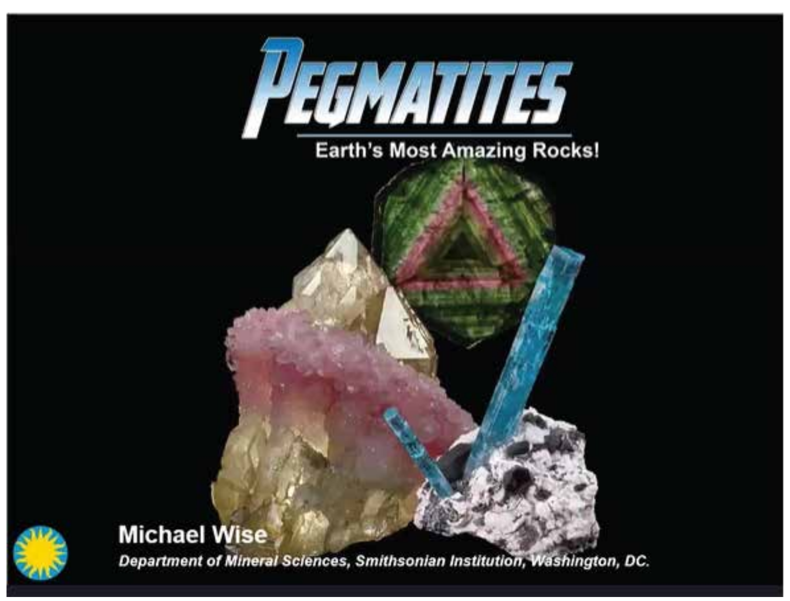
Critical Source:
Pegmatite Expert Michael Wise PhD

A proposed new mineralogical classification system for granitic pegmatites

Michael A. Wise* leading pegmatite scholar in US

"Earth's most amazing rocks". Michael Wise, from the Department of Mineral Scien
the Smithsonian's National Museum of Natural History (NMNH),

CRYSTALLIZATION OF 'POCKET' BERTHIERINE FROM THE
PULSIFER GRANITIC PEGMATITE, POLAND, MAINE, USA
MICHAEL A. WISE



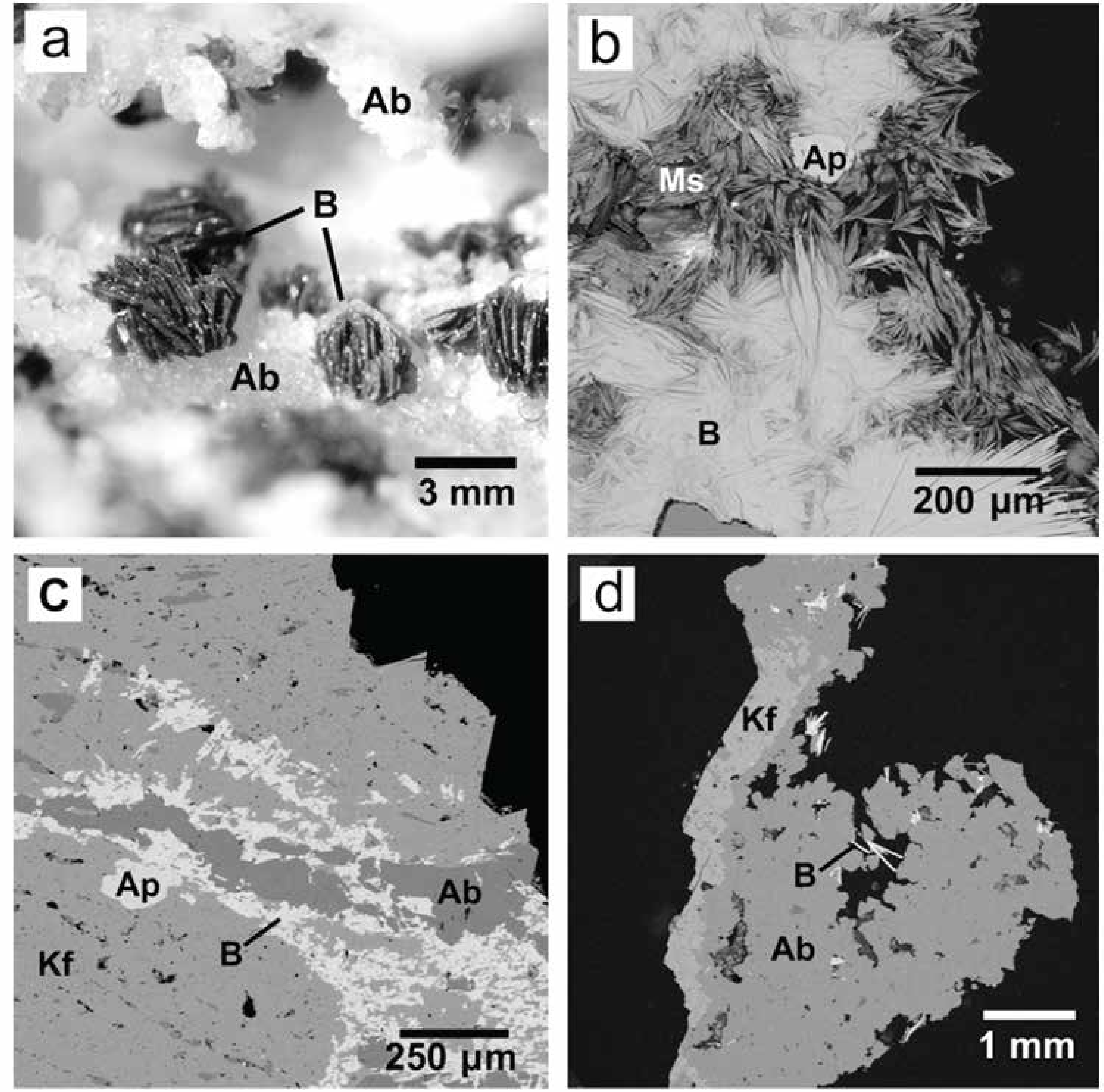


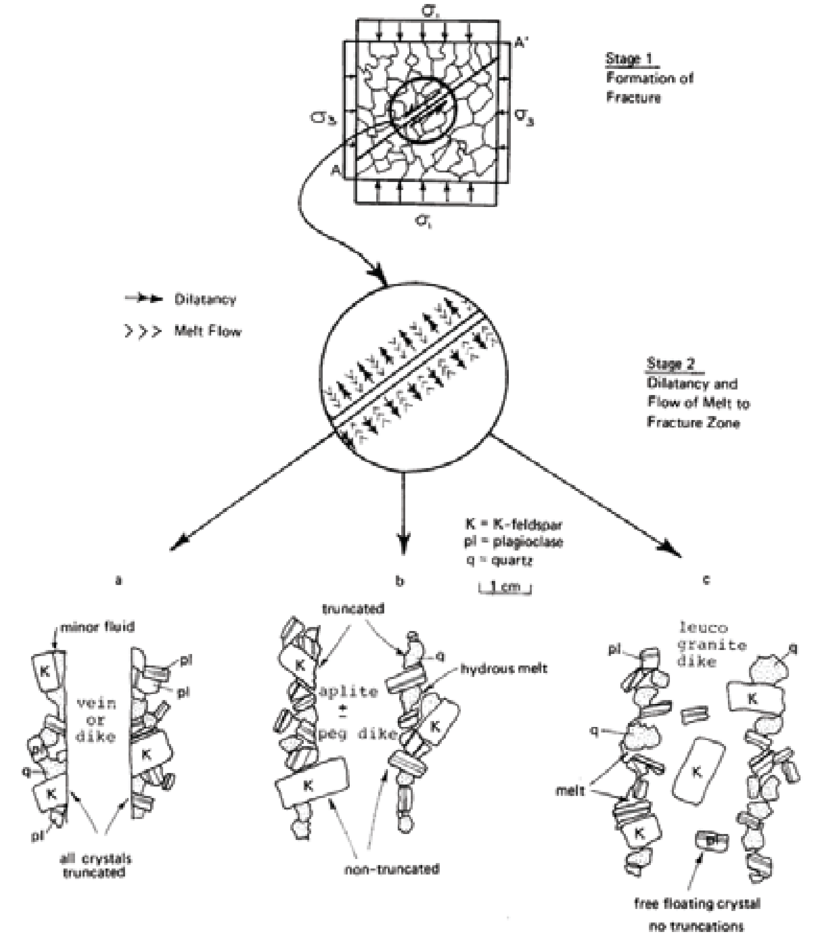
Figure 2. Textural relationships of berthierine and associated minerals in the Pulsifer pegmatite. (a) Euhedral crystals of berthierine. (b) Plumose aggregate of berthierine with muscovite. (c) Albite with berthierine fracture-filling in microcline. (d) Berthierine laths (white) in vuggy recrystallized albite. Kf – microcline, Ab – albite, B – berthierine, Ms – muscovite, Ap – apatite.

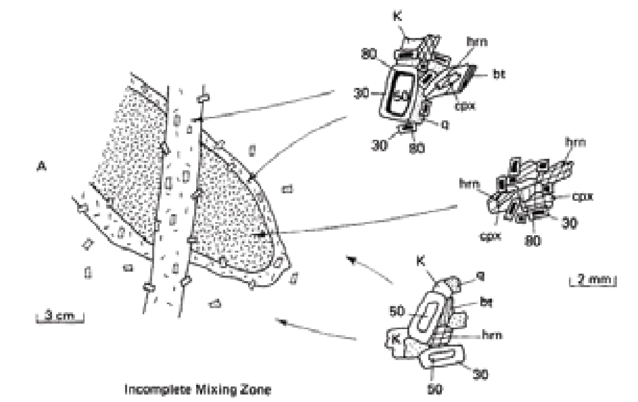
Critical Connection:
Enthusiastic Expertise

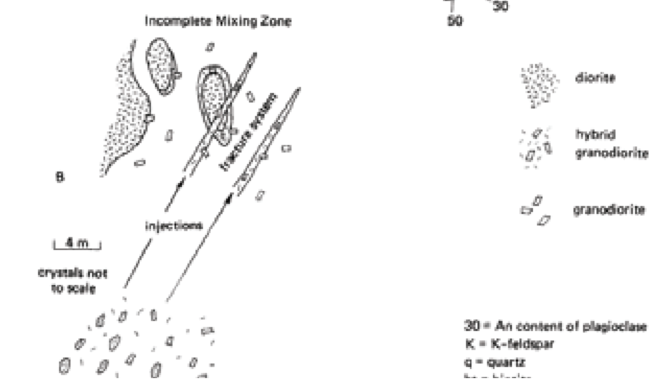
Landform Building: Architecture's New Terrain
Stan Allen, et al

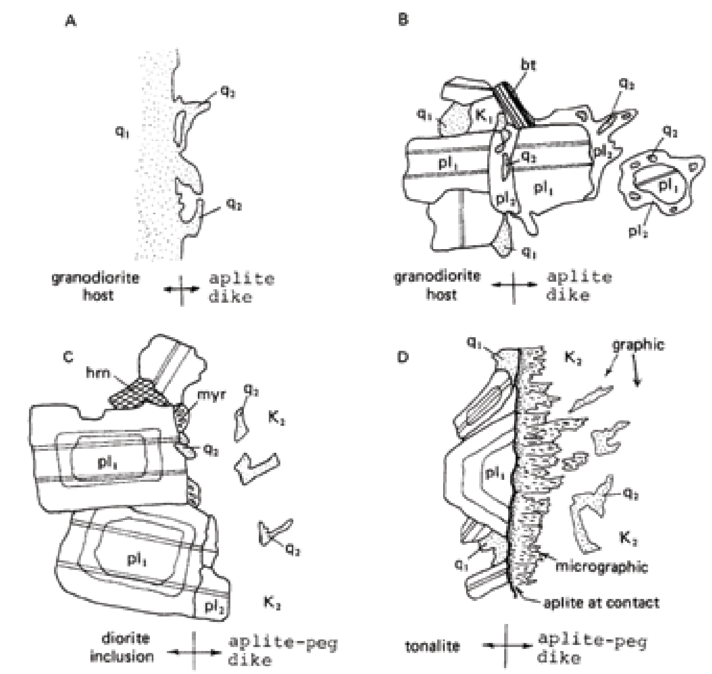
Critical Source:
Fracturing and Diking in Incompletely Crystallized Granitic Plutons
M.J. Hibbard, R.J. Watters

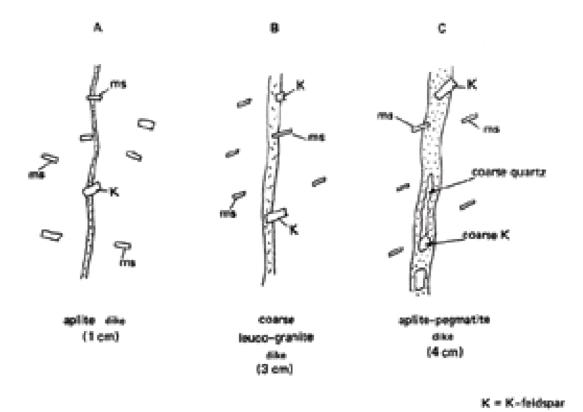
Dikes in granitic plutons commonly have mineralogic and textural characteristics indicating a genetic relation to their host. The contact between the dike and the host is marked signifcantly by interlocking unfractured crystals rather than by truncations and overgrowths, although megascopically the contacts between dike and host pluton may be exceedingly sharp and planar. An explanation of these relationships by fracturing an incompletely crystallized host, rather than by entirely post magmatic fracturing with subsequent diking, is postulated to be consistent with experimental date and certain petrologic observations. Published experimental research indicates that fracturing of crystal-melt systems may occur if there is at least 70% crystals in the system at which point the system is capable of transmitting compressive and shear stresses via a crystalline framework. Dilatancy pumping of melt into fracture zones and subsequent hydraulic fracturing is thought to be one possible way late-stage fluids of granitic systems evolve into dikes in granitic plutons such as leucogranites, aplites and pegmatites. Interlocking textures between dike and host may also develop if magma from some distant source is interjected along the plane of fracturing in crystal-melt systems.

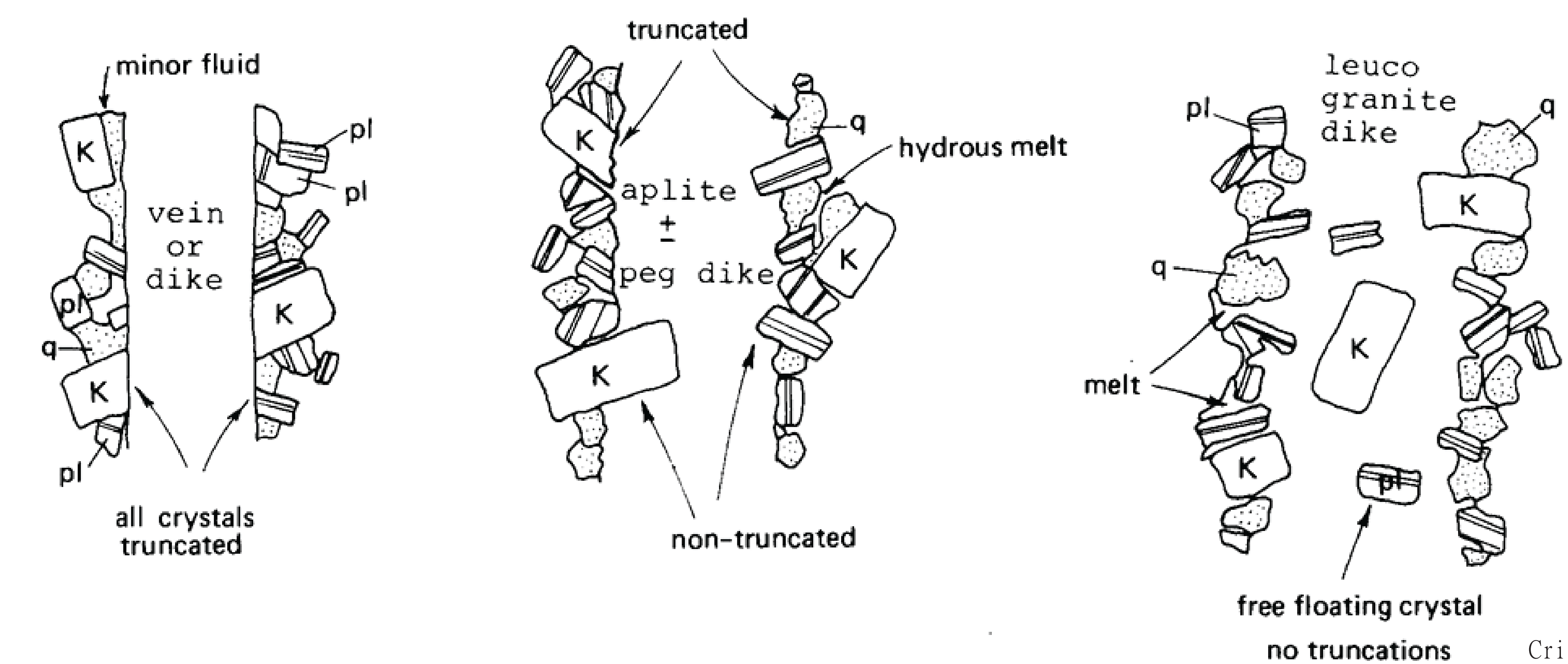












Critical Connection:
For the Love of Diagrams - Architectural Complexity in Pegmatites
"Mixing Zones"

*******Industrial structural geology : principles, techniques and integration

By: Richards, F. L.

-The association of folds fractures J. W. Cosgrove

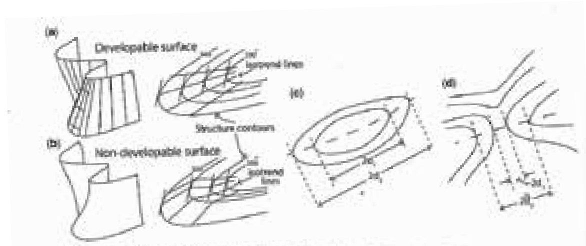


Fig. 16. (a) A developable surface showing points with identical dip and strike values. The lines linking these points (the isotrend lines) are straight. Such surfaces are surfaces of no strain (e.g. a cylindrical flexural flow fold, Fig. 2). (b) A non-developable surface. Such surfaces cannot have zero strain and the isotrend lines are curved. (c, d) Other examples of non-developable surfaces: (c) elliptical structure contours, i.e. a pericline that has positive Gaussian curvature; (d) hyperbolic structure contours, i.e. a saddle that has a negative curvature. From Lisle (1994).

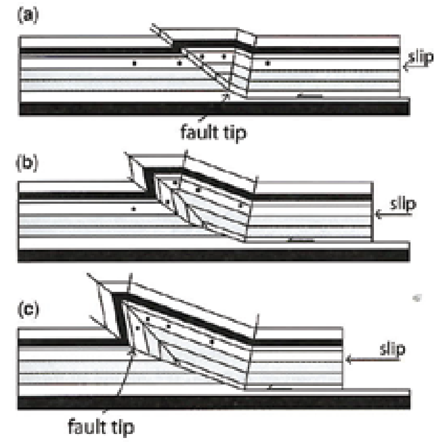
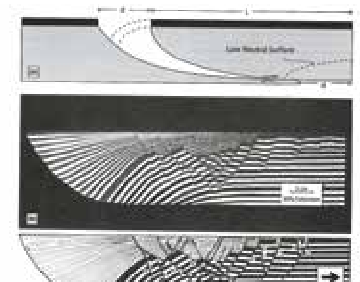


Fig. 11. The evolution of a fault-propagation fold (see text). From Suppe & Medwedeff (1990).



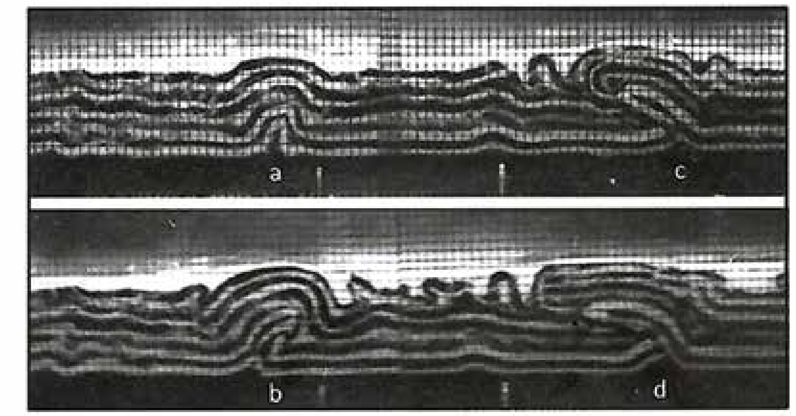


Fig. 9. Two stages in the deformation of an analogue model made of gelatine layers lubricated by vegetable oil. The model was subjected to layer-parallel compression and shows various stages **(a–d)** in the formation of a thrust from a symmetrical, detachment box fold.

62 J. W. COSGROVE

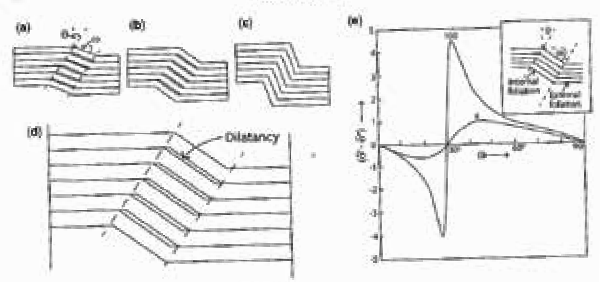


Fig. 25. (a–c) Stages in the evolution of a kink-band showing the initial dilatant phase which reaches a maximum when (d) the layering within the kink-band is normal to the kink-band axis (i.e. when α = β). (e) The graphical expression of equation (8) for two materials, one with a low mechanical anisotropy (N/Q = 5) and the other with a high mechanical anisotropy (N/Q = 100). After Summers (1979).

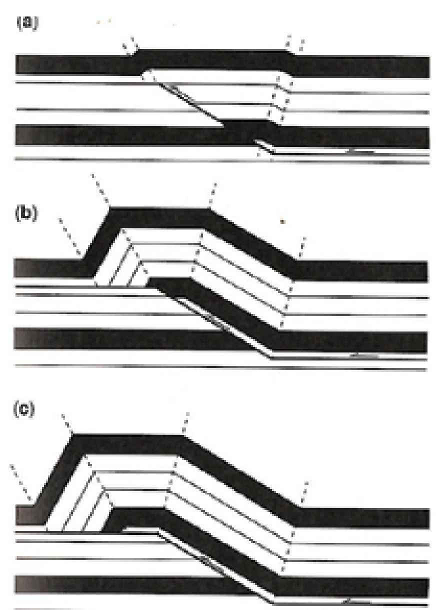


Fig. 6. **(a–c)** Three stages in the evolution of a fault-bend fold by thrust movement over a ramp that cuts through the stratigraphy to link two bedding-parallel flats. After Suppe (1985).

46 J. W. COS

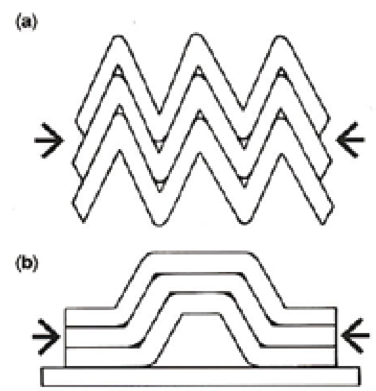


Fig. 8. Two possible modes of buckling of a multilayer in response to layer-parallel compression. (a) Upright folds with axial planes normal to the maximum compression form. **(b)** A box fold with conjugate axial planes inclined to the maximum compression form. A transition occurs between modes (a) and (b) as the mechanical anisotropy of the multilayer increases. From Price & Cosgrove (1990).

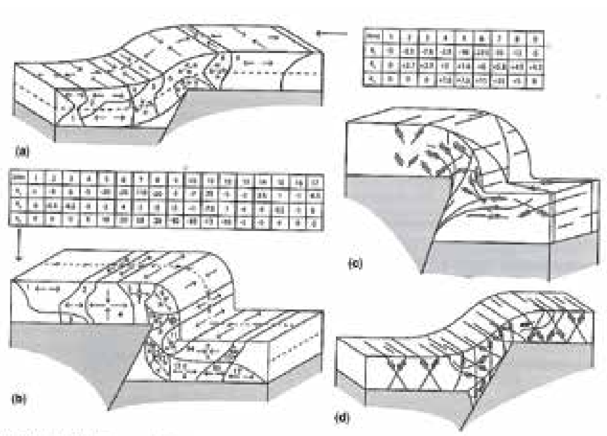


Fig. 12. (a) Block diagram of a forced fold model formed over a planar, normal, basement fault with a 60° dip and 3 cm displacement. The fold is divided into zones depending on the level of strain normal (e_1) and parallel to the layer (e_2 parallel to the fold hinge and e_3 normal to it). (Note: extension is negative and contraction positive.) **(b)** Block diagram of a forced fold model formed over a planar, reverse, basement fault with a 60° dip and 5 cm displacement divided into zones according to the level of strain (e_1, e_2 and e_3). **(c, d)** The macroscopic faults predicted to form in response to the strain fields shown in (b) and (a), respectively. From Ameen (1990).

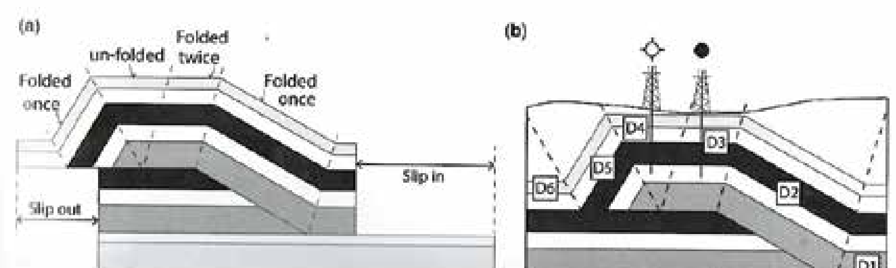
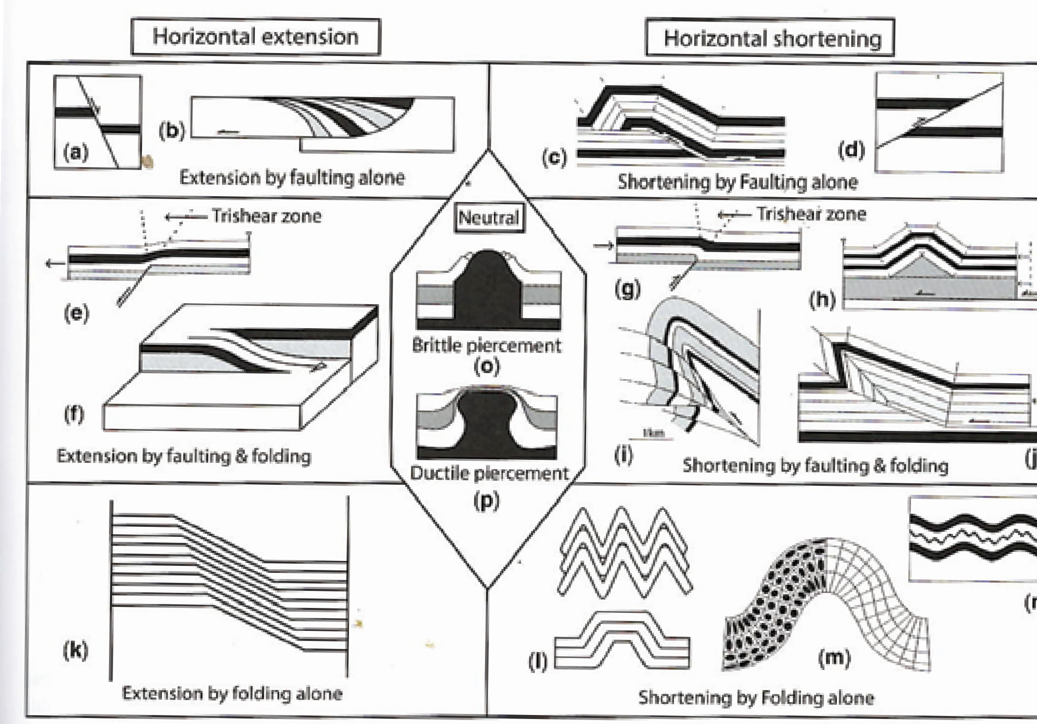


Fig. 7. The subdivision of a fault-bend fold on the basis of the amount of deformation each subarea (D1 to D6) has



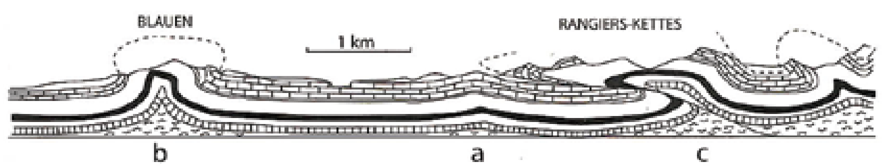
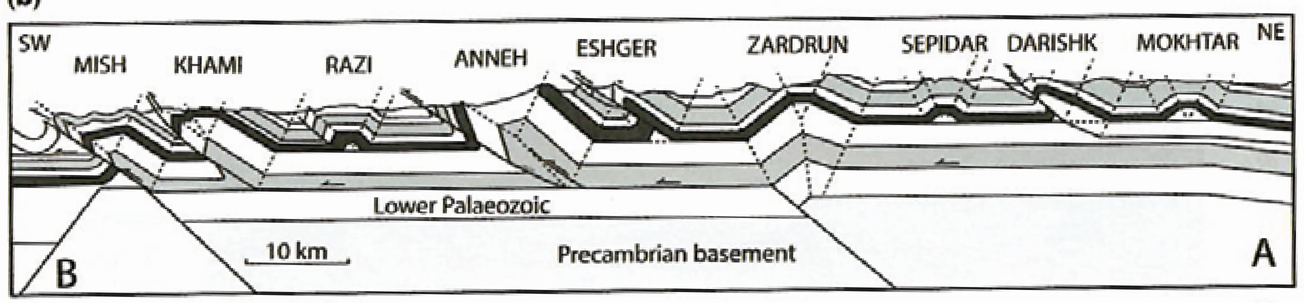


Fig. 10. Detachment folding of Jurassic limestones above an evaporite décollement. **(a–c)** Three stages in the evolution of a thrust from a box fold. From Heim (1921).

(b)



ithin the fold profile is independent of fold shape.

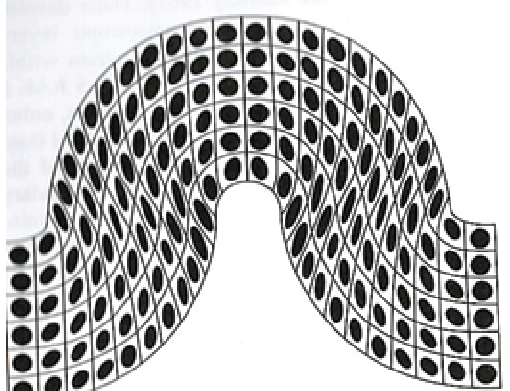


Fig. 2. The strain distribution within a buckle formed in a homogeneous anisotropic layer such as a shale or well-bedded sedimentary succession. The strain is the result of bedding parallel shear and is zero at the hinge and maximum on the limbs. From Ramsay (1967).

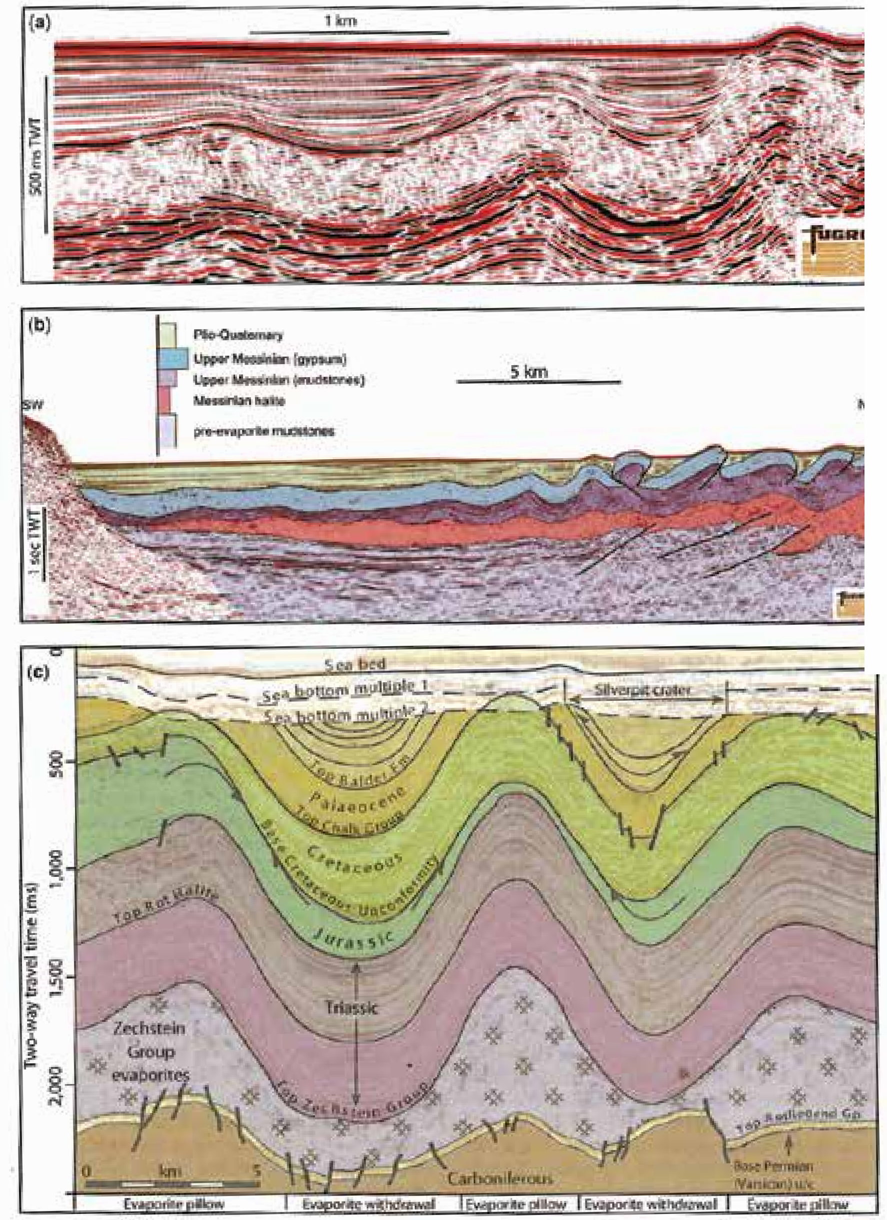


Fig. 17. **(a)** Growth folding of Messinian strata (likely to be massive primary gypsum) on the floor of the Western Ionian Sea just off the Malta escarpment. **(b)** The regional setting of the buckles shown in (a) which are formed behind a thrust complex (interpretation R. Butler). **(c)** Buckled multilayer of Mesozoic sediments lying on Zechstein evaporites in the Silverpit Basin, Southern North Sea (interpretation J. Underhill). From the Virtual Seismic Atlas, University of Leeds, UK.

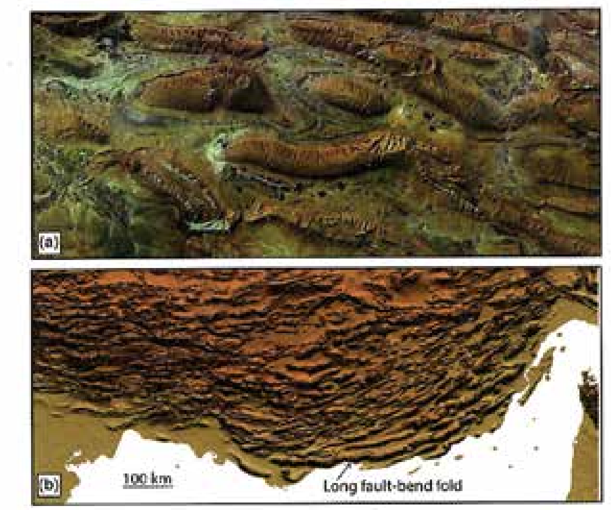


Fig. 20. **(a)** Satellite image of detachment folds in the Fars Fold Belt of the Zagros Mountains (see Fig. 19a). They formed behind major fault-bend folds (e.g. the long folds in (b)). Note their small aspect ratio compared with the fault-bend folds arrowed in (b). **(b)** Satellite image of the Fars Fold Belt of the Zagros mountains showing clearly the long, linear hinges of the fault-bend folds defining the margin of the Persian Gulf and the relatively short hinges of the buckle (i.e. detachment) folds behind them.

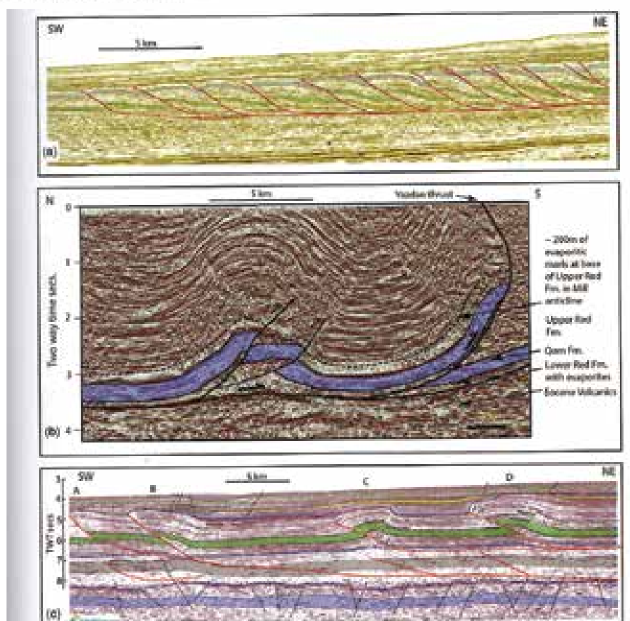


Fig. 18. (a) A deep-water thrust belt, offshore Namibia (interpretation by R. Butler). (b) 2D seismic profile showing the thin-skinned deformation style (detached on Lower Red evaporites) of the Qum area, Central Basin of Iran (interpretation C. Morley). (See Morley 2009.) (c) Seismic section showing various stages in the formation of fault-bend folds associated with thrusts in the Niger Delta (interpretation by F. Peel). All images from the Virtual Seismic Atlas, University of Leeds, UK.

Critical Connection
Stealing from Oil Barons: Industrial Treasure Maps and the "Megasection"

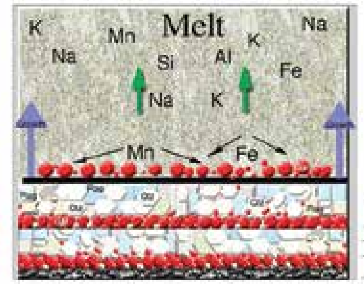
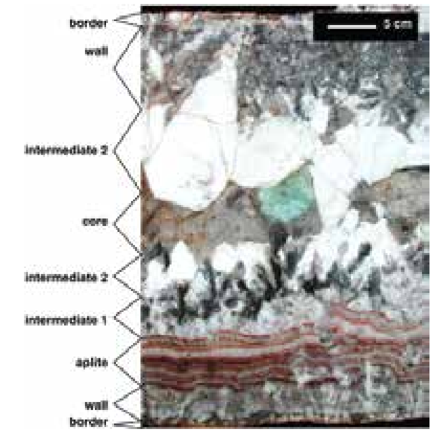
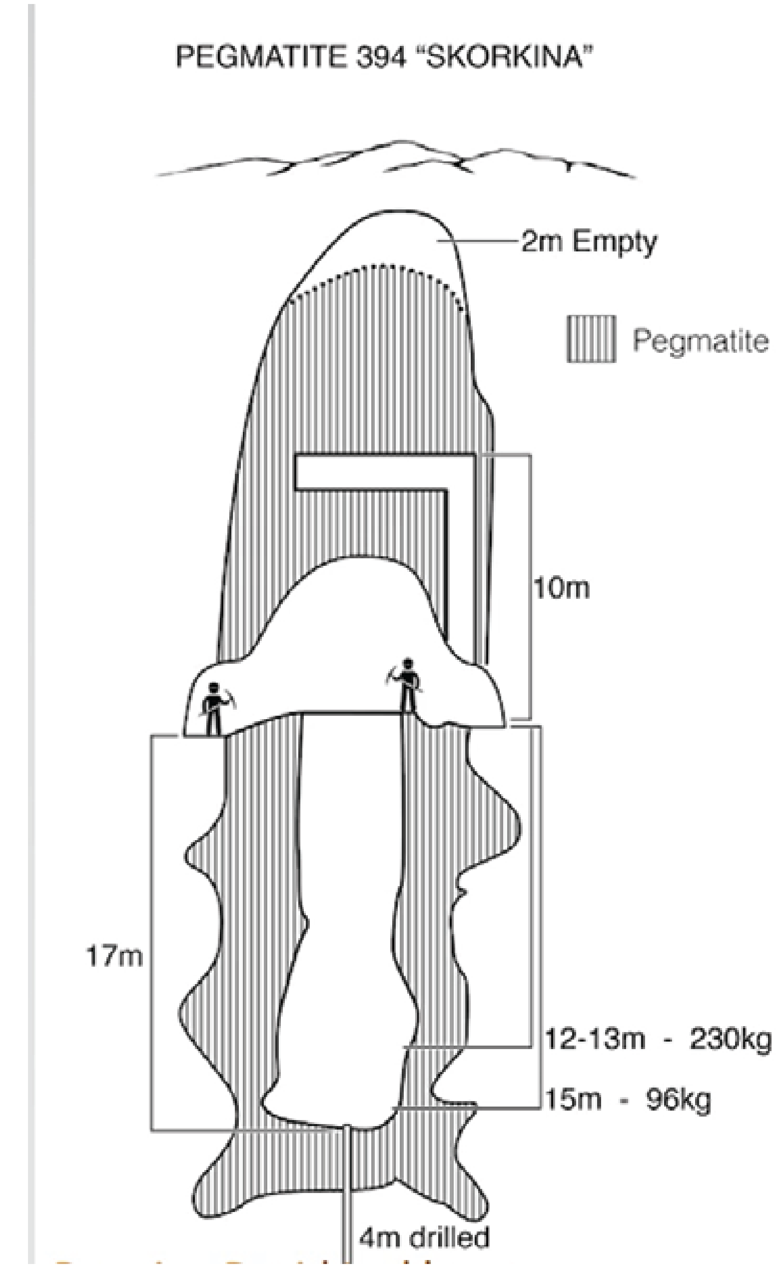


Figure 21. Diagram showing crystallization of garnet at the boundary layer during the formation of line rock. Mn and Fe diffuse to the growing crystals, whereas excluded components such as Na, K, and volatiles diffuse away from the crystallization front. Crystallization of garnet continues until the boundary layer is depleted in Mn and Fe, at which time phases such as quartz and albite nucleate and grow (Webber et al. 1999).





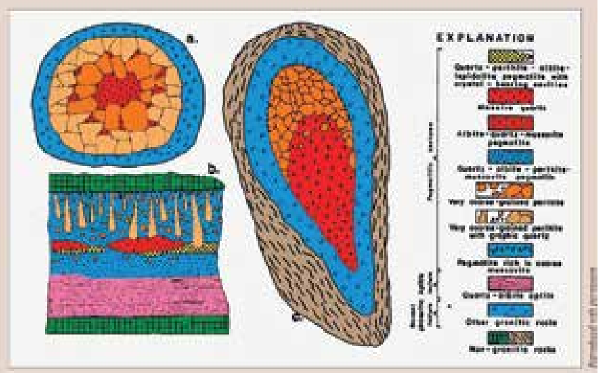
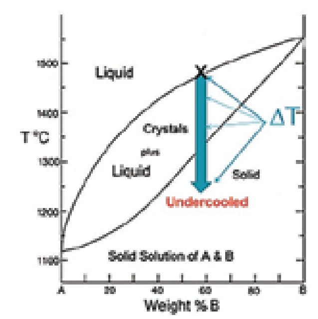


Figure 15 (right). Idealized diagrams of pegmatite zoning: (a) symmetrically zoned miarolitic pod in granite; (b) asymmetrically zoned pegmatite dike with aplitic footwall; (c) vertically asymmetrical ellipsoidal pod of pegmatite with a "hood" zone (modified from Jahns and Burnham 1969).



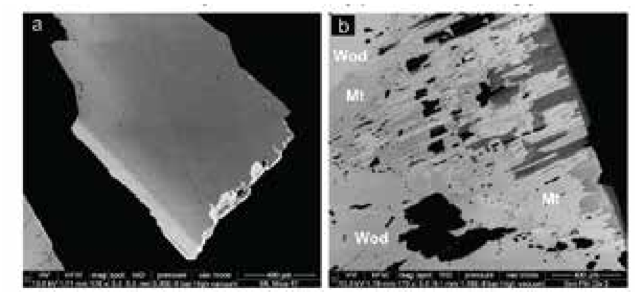


Fig. 4 Back-scattered electron (BSE) images of Nb–Ta oxide minerals [illegible]

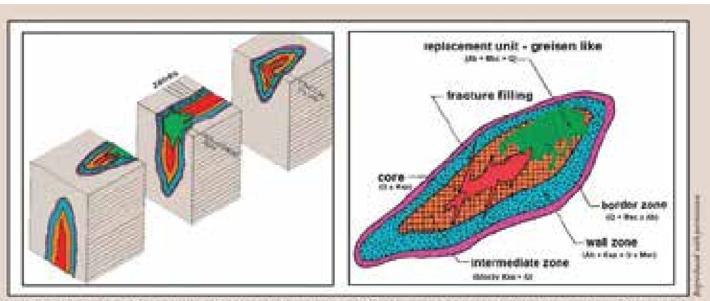


Figure 14 (above). Idealized diagrams of complex pegmatites. Replacement units (green) cut primary zones. *Left,* modified from Cameron et al. (1949). *Right,* replacement controlled by lithology and fractures (modified from Černý 1991).

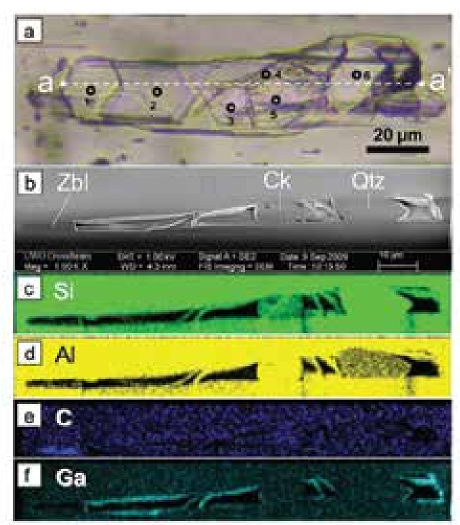
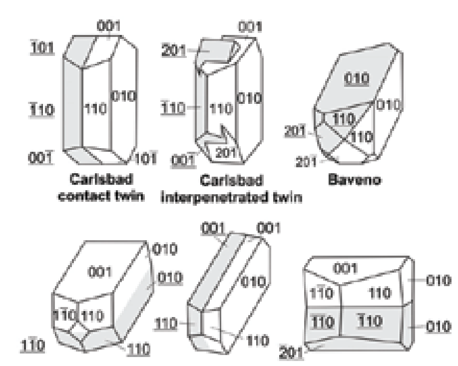


FIG. 5. (a) Photomicrograph of a large blade-shaped inclusion in spodumene from the Tanco pegmatite, showing the location of each Raman analysis (numbered circles) and the trace of the cross section a–a' shown in Figures 5b, c, d, e and f. (b) SEM image of cross section a–a' showing zabuyelite (Zbl), cookeite (Ck), quartz (Qtz) and void space once occupied by the aqueous fluid and vapor bubble. The relative distribution of Si, Al, C, and Ga is shown in Figures 5c, d, e and f, respectively. Thin layers of redeposited material within the void spaces are enriched in Ga from the ion beam.



Some common twinning laws in feldspars. Modified after Deer et al. (2013).

Figure 11. William Gilpin. *A Ruined Abbey*. 1789. Ink and watercolour. Gallery Oldham.

Figure 7. John Ruskin. 'Hospital, Pass of St Gothard'. August 13, 1835. Pencil and Ink. Ruskin Library, Lancaster (RF 2044).

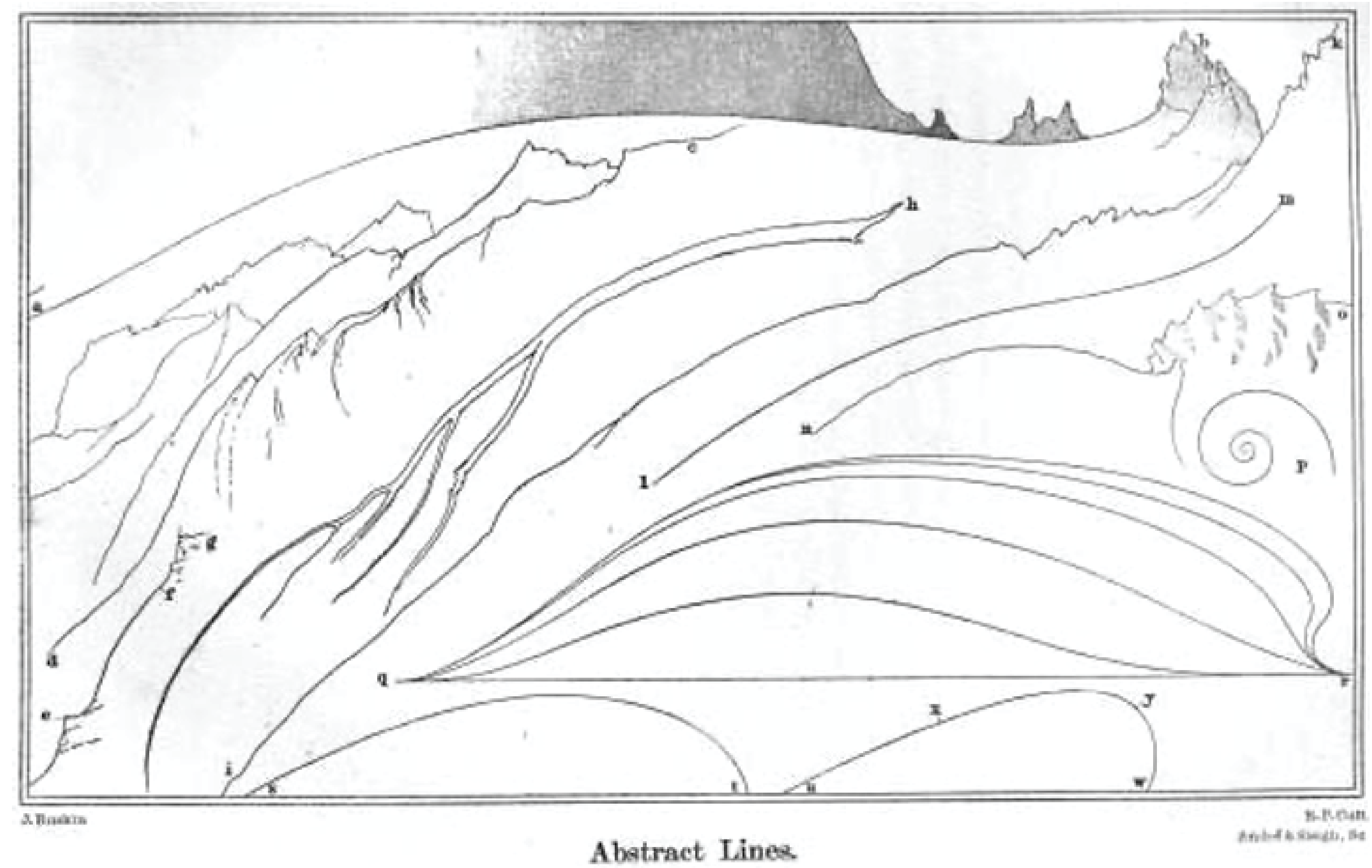


Figure 26: John Ruskin. 'Abstract Lines', from *The Stones of Venice,* Volume 1. 1851. Engraving.

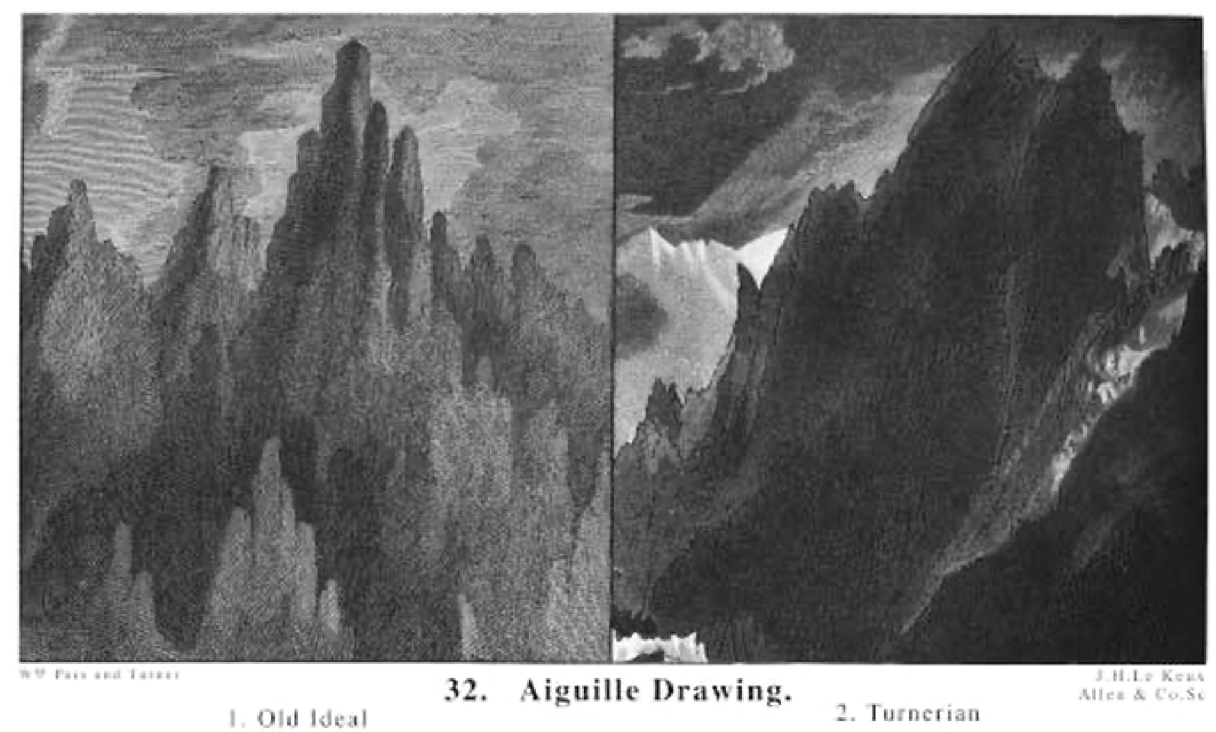
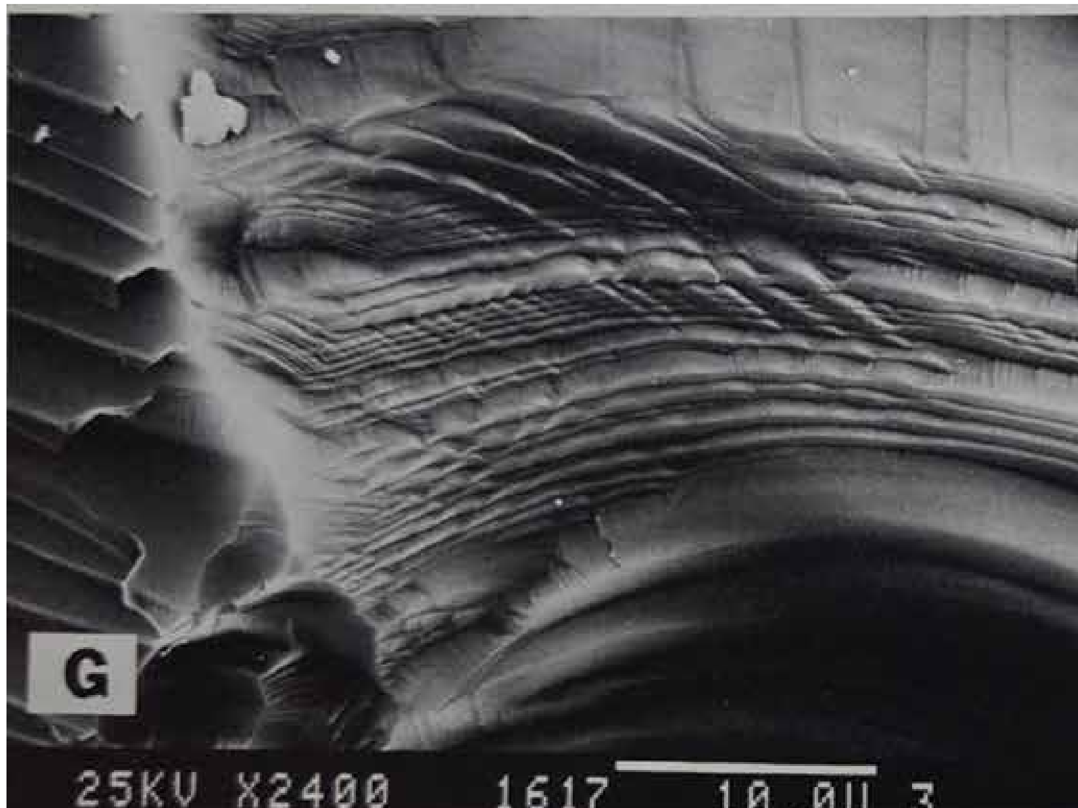


Figure 4: John Ruskin. 'Plate 32: Aiguille Drawing' from Volume 4, *Modern Painters*. 1856. Engraving.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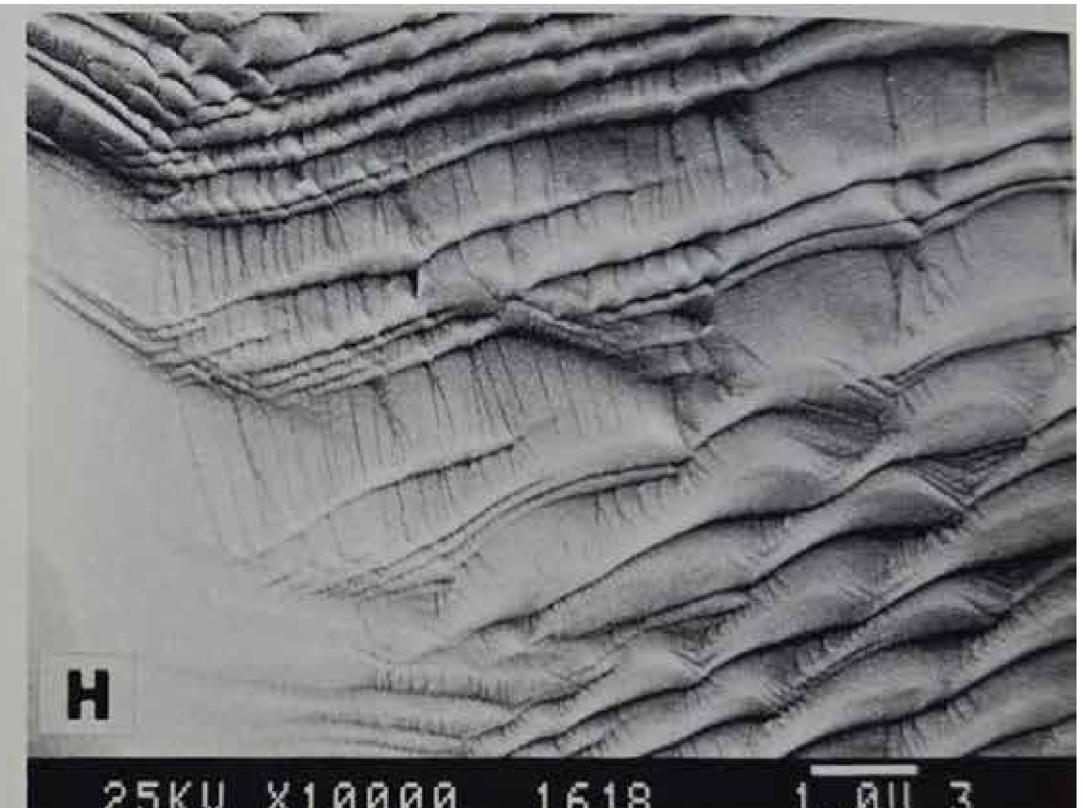
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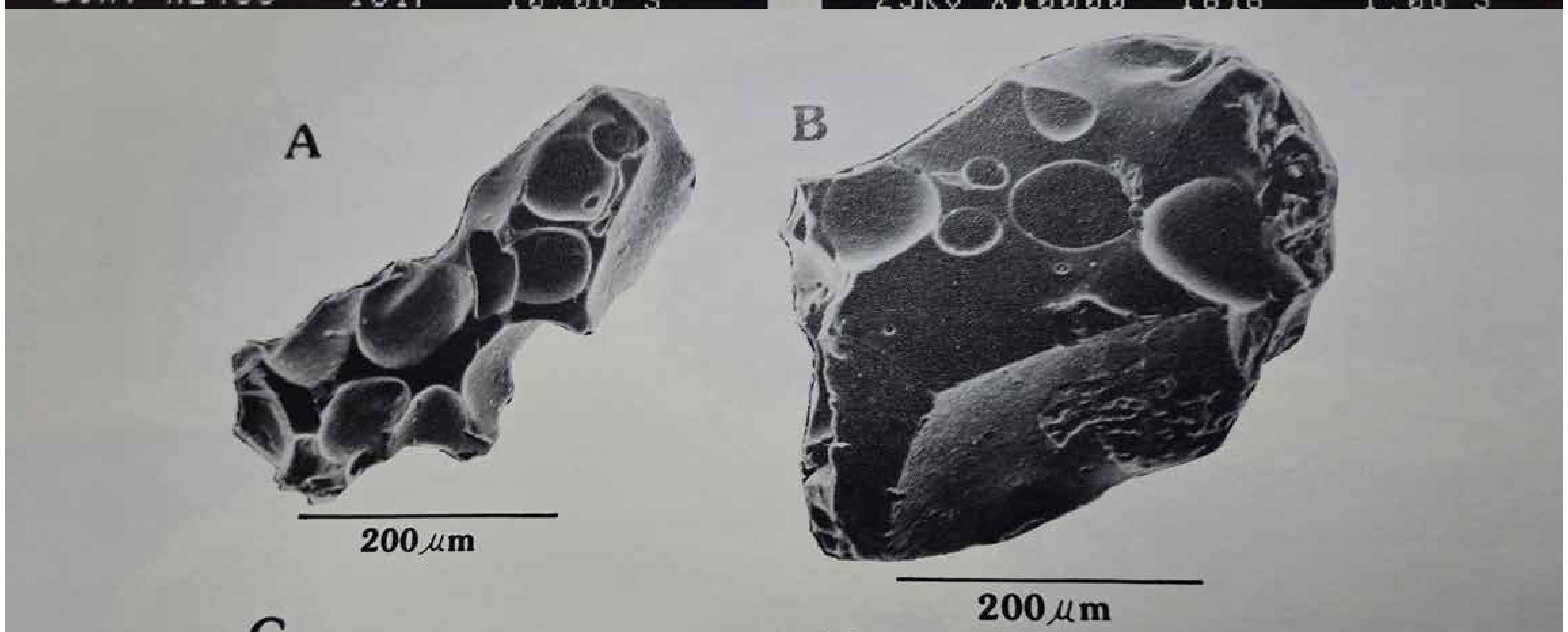
A
B
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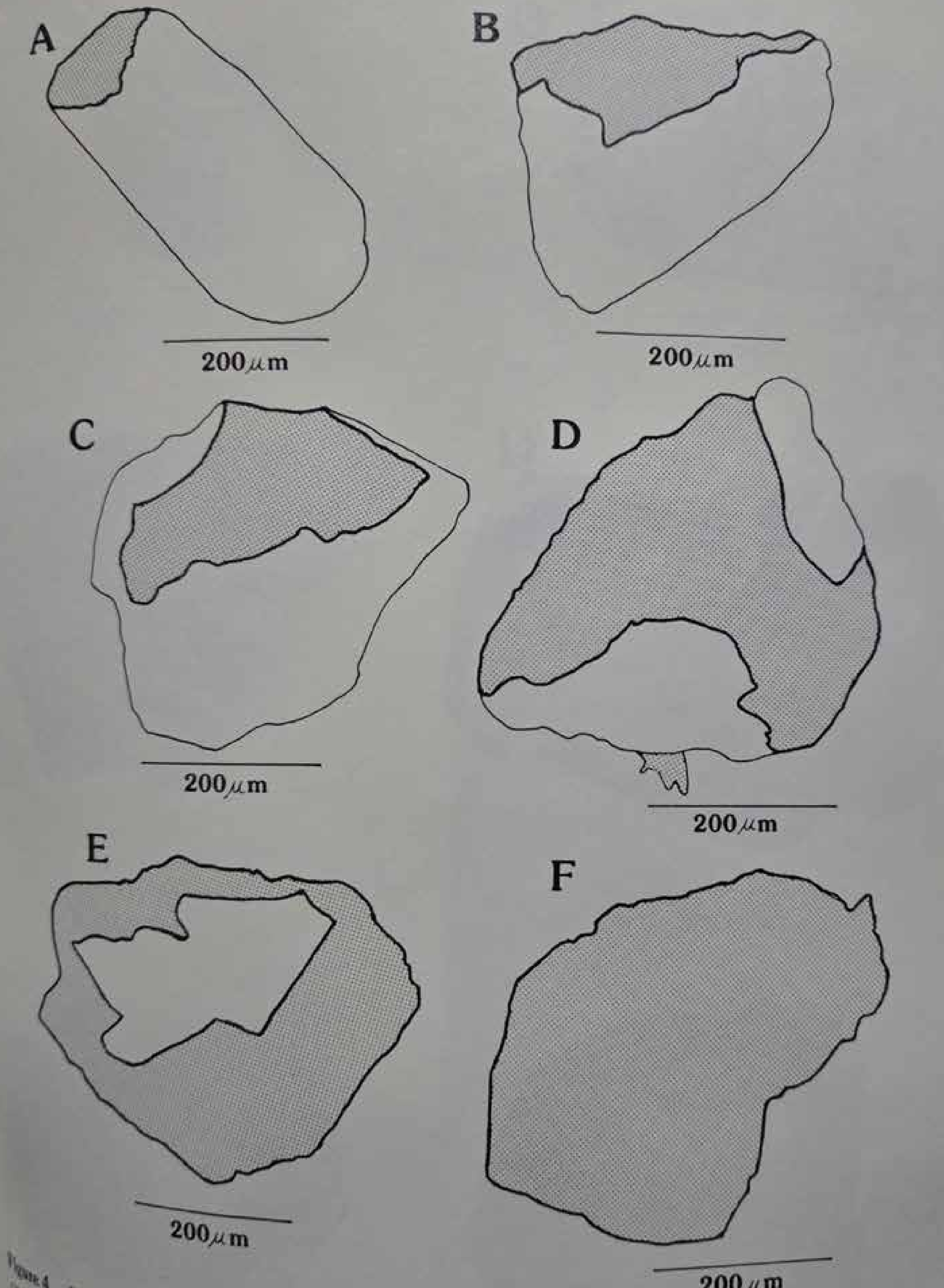
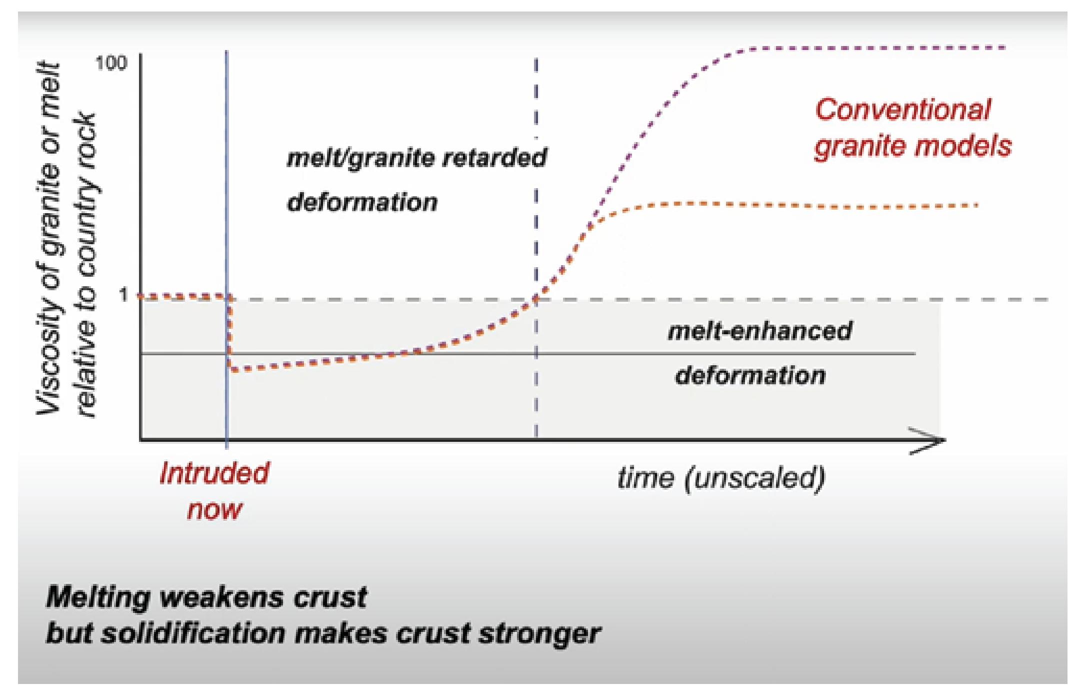


Figure 4. Percent of freshly broken surfaces on crystals. C_{bc} is the ratio of the broken surface area on crystal image to the cross-sectional area of the grain. A—$C_{bc} = 0.1$; B—$C_{bc} = 0.25$; C—$C_{bc} = 0.4$; D—$C_{bc} = 0.65$; E—$C_{bc} = 0.7$; F—$C_{bc} = 1.0$. The broken area is shown by the stippled pattern in the line drawing.

Mineral species	Gem variety	Colors
Beryl	*Aquamarine*	blue and green
	Emerald	green
	Goshenite	colorless
	Heliodor	yellow
	Morganite	pink to orange
Topaz		colorless, blue, brown
Elbaite (Tourmaline Group)	*Achroite*	colorless
	Canary	yellow
	Indicolite	blue
	Paraiba	blue, green
	Rubellite	red to pink
	Verdelite	green
Spessartine (Garnet Group)		orange
Spodumene	*Kunzite*	pink to purple
		green



USE OF FRACTAL VALUES TO CHARACTERIZE THE MORPHOLOGY OF HIGHLY IRREGULAR PARTICLES

Particles in Thin Section

Figure 8 shows the outlines of four particles taken from thin sections, none of which could be easily classified by existing methodology. All these sections are taken from Carozzi (1960), though originally from elsewhere. Figure 8*A* concentration. Figure 8*C (Q1)* and 8*D (Q2)* show two quartz particles (again from thin sections which have both suffered extreme chemical etching in an alkaline environment, to allow replacement microcrystalline calcite to occur (Alimen, 1944). Such active dissolution has left highly irregular grains.

It is obvious that any purely descriptive assessment of these outlines will run into difficulty because of their great complexity. The use of Fourier analysis would be invalidated if relying on the radial line method, as the mul-

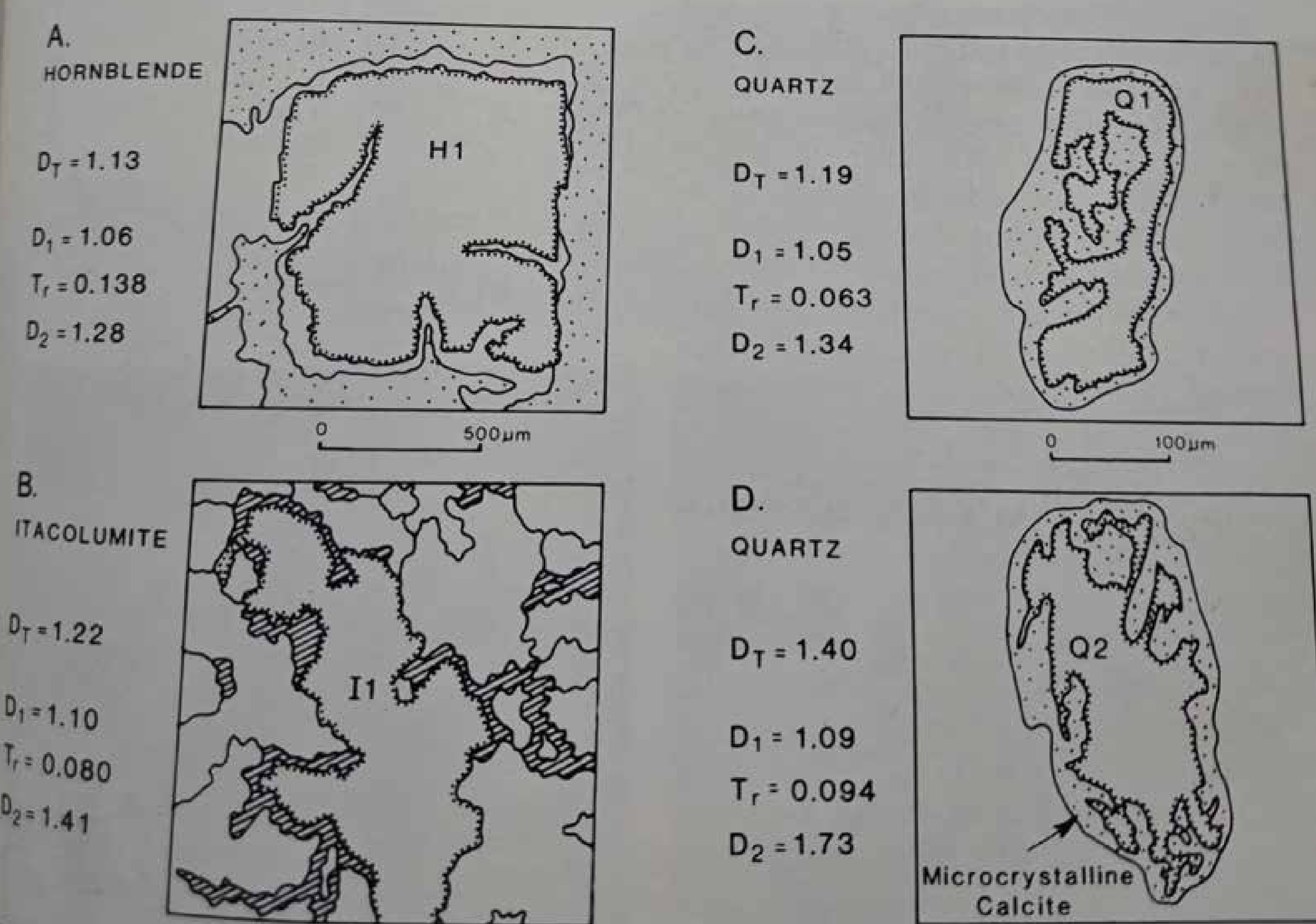


Figure 8. Examples of fractal characterization of irregular particle morphologies in thin sections. Source of figures and discussion of fractal values can be found in the text of the paper.

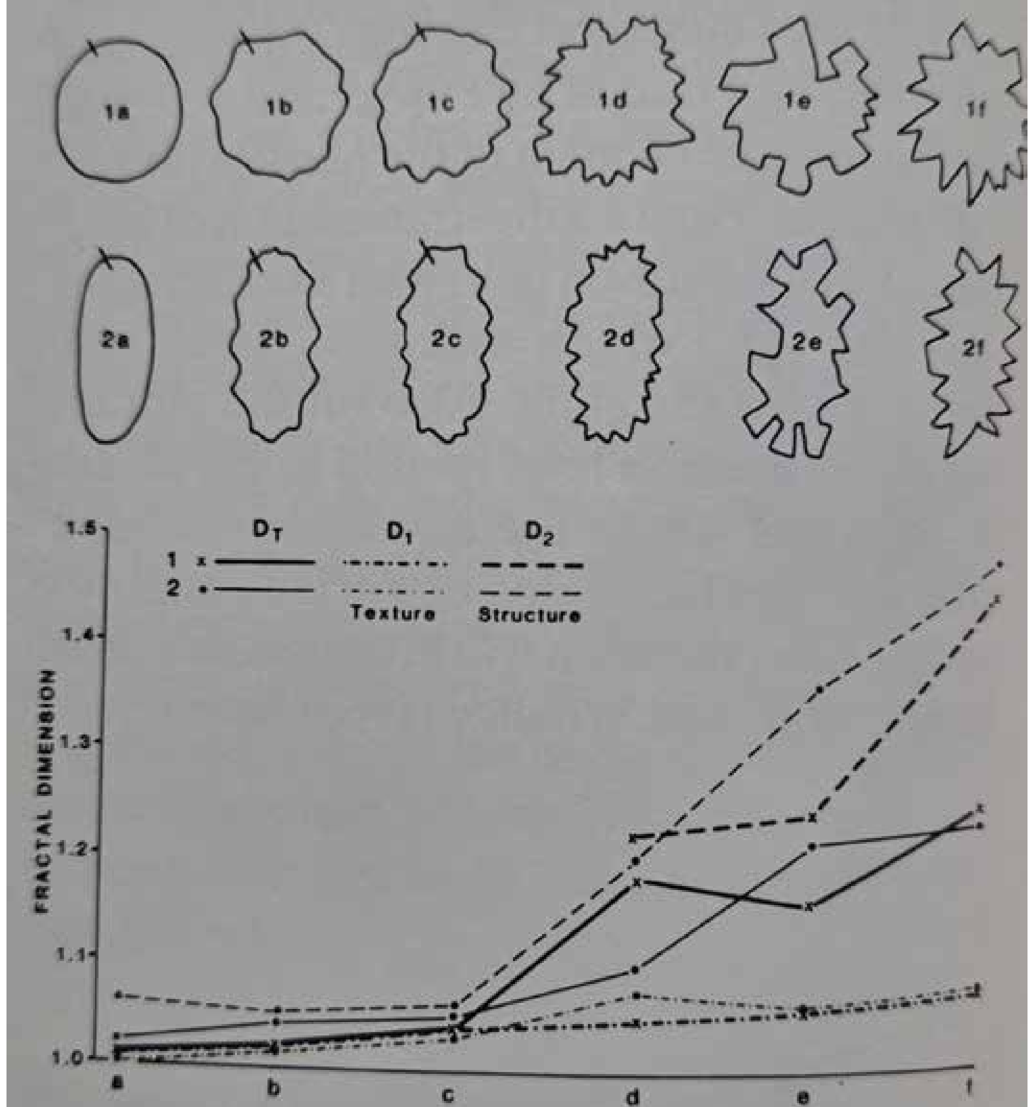
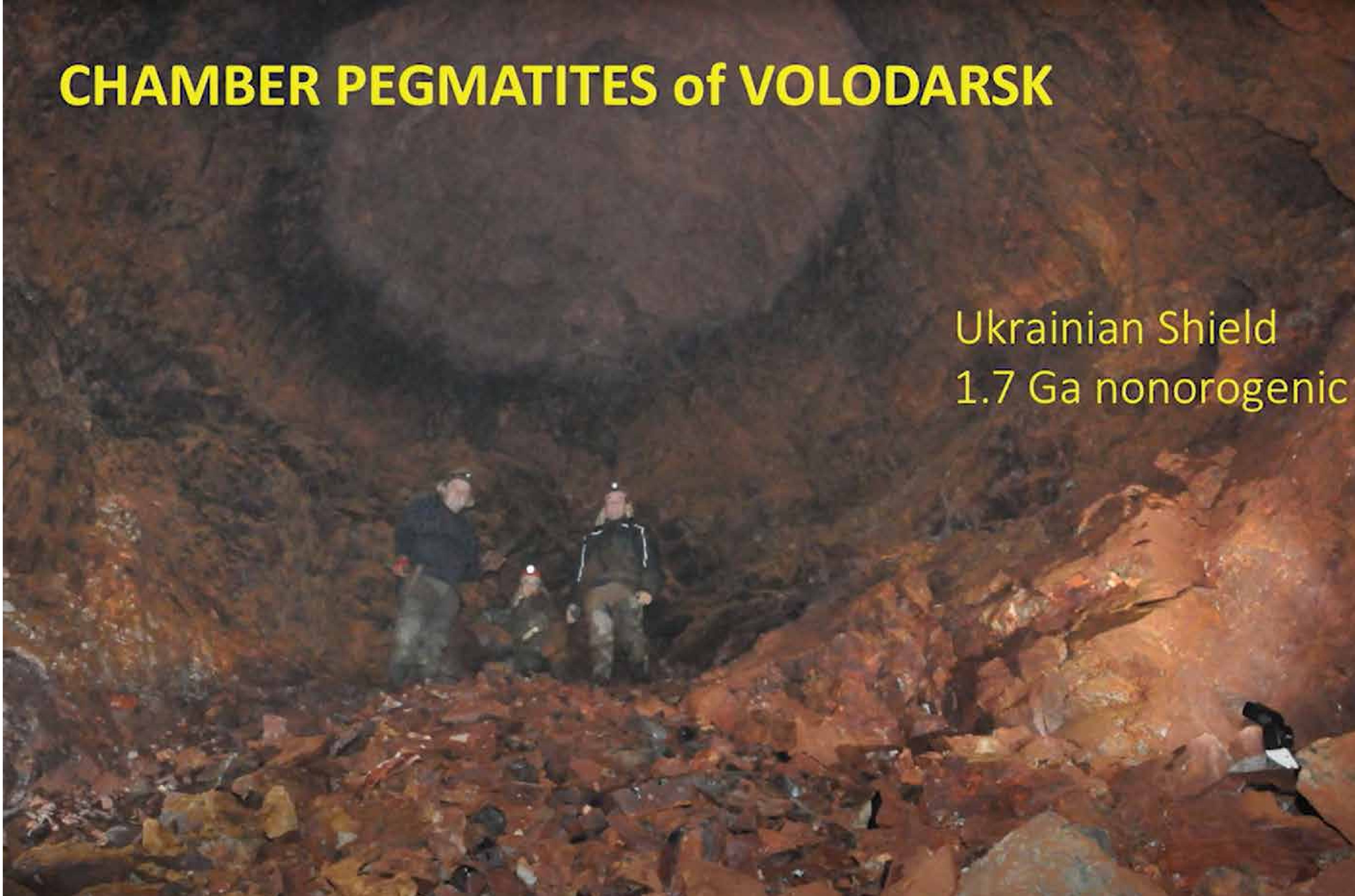


Figure 7. Calibration of fractal values using synthetic morphologies. Particles a–f show increasing crenellate edge morphology. Thick lines (*1*) refer to the top row of forms and thin lines (*2*) refer to the bottom row of forms. Note that not all of the fractal values are shown. Values of D_2 for particles *1a* to *1c* are nearly identical to the values of D_1 and D_T and omitted for visual clarity.


CHAMBER PEGMATITES of VOLODARSK
Ukrainian Shield
1.7 Ga nonorogenic

Growing up in Charlotte in the 90's, the city didn't have quite the feel of vibrancy, growth, and development it has these days. It felt old, stagnant, not like anywhere the news would mention. There was always art and music and theatre, yes, but it didn't feel like a place an artist or musician would want to stick around. I suppose I fancied myself and artist and a musician, and in many ways, the ways in which I make art tend to influence my journey through life in profound ways (and often the reverse is true).

It was home, and ultimately it was a place I wanted to move away from, and for ten years, I did just that. When I went from a city of about 800,000, at the time, to a county of about 70,000, Asheville-Buncombe felt micro-scaled. However, as time went on (and I bore witness to Charlotte's facelift in intermittent spurts), I started to feel like the sprawling mini-metropolis my hometown was becoming might have more to offer than the increasingly crowded (and expensive) bohemian mountain art-hub.

Though I'd studied oil painting some in Charlotte, the real ah-ha for me in Asheville was when I took my first 3D-design and sculpture courses. It was the same sort of instant wonder and attachment one feels when they first begin to study architecture. While I was a part-time construction grunt in a painting class, I was starting to dream up "birdhouses" and picking off some of the details I'd see at work. Images like a half-demolished kitchens or stacks of glossy tile became objects in still lives, sculptures, and doodles long before I ever considered designing them. The irony that I made paintings inspired by architecture almost ten years before I learned the difference between Frank Lloyd Wright and Frank Ghery, is, well, tremendous.

But ironies and accidental overlaps have been a motif in my life. So too have been the ebb and flow between disciplines. How I've defined myself as an artist has varied substantially throughout the years: I started drawing and playing guitar somewhat seriously rather young; in college I wanted to write like everyone we read in my literature classes and I tried into my artwork to bring colors and themes from my jobs in the kitchen of a labyrinthine resort and remodeling houses– between sessions of working on my crossword of a thesis, I was in the metal shop clumsily tacking together my first steel sculptures; fast-forward to working Sundays at the gallery and spending my weekdays building houses or scrubbing high-end toilets to pay the bills.

To stuff it all into one run-on sentence, it sounds chaotic, and in many ways tumbling through the broad swath of "the arts" is, in fact, as much of a whirlwind as it sounds. However, the overlaps and synergies I've found between all the various disciplines have culminated in a very generalized set of skills and experiences that have all nudged me toward a great appreciation for architecture as a deep and complex way of looking at the world. Throughout the program thus far, I've tried to incorporate some of the influences I

use in my art, into my architecture. Influences like science fiction stories and live music have bled over into how I have thought about some projects, and I expect an outward-looking interdisciplinary lens to influence how I think about architecture in any future practice.

This summer, I was rooting around my bookshelf for inspiration for new paintings, and I picked up a very large, very old dictionary. Picking words at random was an exercise we used in my sculpture class for quick association-based ideation. It wasn't long, however, before I was enamored by the large volume of geology terms in just the first few pages. Over the summer, I gave myself a miniature crash-course in geology and mineralogy. Only after more rigorous reading and several whimsical paintings later, did I finally begin to find some more traceable connections between my newfound interest and my current academic undertaking.

Building with rocks and appreciating geology are nothing new in architecture, and ideas like weathering and terms like "tectonic" are near and dear to architecture, not to mention the vast global catalogue of stone masonry buildings. There is in fact a rich recent history of writing on geology in architecture – or more often, writing on architecture through geology. What I hope to continue reading and researching involves drawing potentially novel connections between complex and heterogeneous intersections of various rock types that could be useful in architecture. My aim is to develop ways to use cutting edge computer and laboratory technology to demonstrate the visual, analytical, and rhetorical connections between "new" geology and "new" architecture, since both are constantly updated with new tools, information, and unique problems.

Given my own interdisciplinary approach to art and academia, it follows that the particular topics in geology that have captivated my attention are those concerned with complexities and variabilities as opposed to certainties and homogeneous topics. I aim to expound upon recent discourses connecting geology and architecture, in order to orient my research in such a way as to be, at least in part, having some novelty.

Specifically, I am most interested in utilizing research surrounding granite pegmatites including their formation, typical morphologies, composition, and especially, how the formative and crystal behaviors and compositions can provide aesthetic data to be repurposed for architecture. By positioning this work as being "toward a pegmatitic architecture," I hope to "mine for" the aesthetic and metaphorical wealth in the study of some of earth's most complex and interesting rocks.

Other topics that have guided my research so far are weathering, cleavage/fracture, large-scale folding/faulting, and clastic (mixed) particles. I am interested in exploring the textural relationships in various rock and mineral species, as well as how analysis at various scales can inform various scales of architectural design.

Build like the Planet:

Beyond Topography: advanced imaging in geology as a means for

Luster, Cleavage, and Weathering in Granitic Pegmatites and the Connections Bet and Architectural Form-making

History and Background

Stone—Marble, Travertine, and the Old World

(History/background stone construction—origins)

From necessity to aesthetics

Architecture and Stone (A Romance)

the Victorians and rock-display / The medievalists (and rocks)

-up through modernists (one could argue that concrete

-interest in the scientific properties that made building stone

-much of discourse circles around extractive industry, ie mining stone to building surface, taking language from Christian/colonial (ref)

-much of the discourse around mineralology focuses on industrial minerals like ra earths, high-end jewelry metals and gems, and collectible showy semiprecious crysta

-architects have been some of the few lay people to approach rock/mineral appreciat from a science-forward perspective. While there has always been a draw to the polished, th architect tends to appreciate duller tones and more nuanced aspects of a rock's personal

Gems, Gold, and Colonialism

Allure, modernism, and industrialization

(History background, mining/extraction, precious jewels—colonialism in Africa/Americas)

(marble gives way to granite—silicosis = the rules of old world fail the new world even chemically)

extraction of gems and metals through large scale ecological destruction of natural occurances=pegmatites are deeply complex and diverse

precoccupation with gems vs destruction of the matrix, focus shift away froma "facetec gems" mentality*

New Order and the Abilities of the Laboratory

prefabrication

Postmodernism et al, smoothing, blobbing, deconstructivism

Digital architecture

Compare/Contrast AI ideation—intricate rapid design vs capacity of observing mine

-3d scanner!?

XRF -(diagnosis and ambiguity—inability to read carbon, etc) and SEM* -visual data from biological samples under scanning electron microscopes is common in archi crossover, however applications in geology have not enjoyed such popularity

Acid tests

Advanced mineralogical science

Latour*

Pegmatites and the New Marble

What are pegmatites?—mostly quartz, biotite mica, and alkali feldspar (some of earth's most common/unremarkable minerals)

Discuss how granitic pegmatites have been used historically as an indica gems/rare earth metals

"But, in this now untenable divide between nature and culture, where human activity produces not only atmospheric change but also geological transformation, where does architecture appear? Can architecture enter the Anthropocene? As the construction of perspective, how will architecture frame the infinite by challenging the here-and now quality inherent in contemporary modes of production. ***I contend that an architecture driven by the desire to radically inflect the perspective of the human with a geologic sensibility—through narrative, serial production, and atypical successions of scope and purpose phasing in and out of sequence—can begin also to connect to the cosmos****."*

- Thomas Provost, "In Infinity, Eternity Performs"

"The impact of virtuality and advanced remote sensing devices should lead architects to reassess Surrealist and Pataphysical[1] concepts of space. There are many similarities between these modes of creativity and the way an architect might perceive, interact and make connections between their architecture and the myriad machinic and natural ecologies that constitute the sites of our contemporary architecture."

-Neil Spillers "Communicating vessels The 'pataphysical exceptions of reflexive architecture."

In the ancient world, the rock was integral in humankind's crawl into consciousness, and while many attribute the beginning of civilization to the taming of fire, the primordial shelters of our ancestors were the subterranean architectures of the cave. These early "prefabricated" spaces would provide not only the basic fundaments of human society, but in addition, their component parts would provide the raw materials that would lead to innovations like toolmaking, ceramics, and jewelry. The discrimination of various rocks and minerals based on hardness, utility, and aesthetic beauty became as natural and necessary as foraging had been. In that regard, geology, one could argue, is one of the fundamental sciences, and it arises directly in tandem with humanity's understanding of materials and spaces that form the basis of architecture as art and science in its own right.

In the time before Vitruvius -or what some might call, the time before architecture- and even for a great deal longer, marbles and limestones built the world. Though wood has just as long a history, when ancient people wanted something to last, most often they turned to the quarry. For the builders of cathedrals, palaces, and ancient cities, it was not the carpenter, but the mason who spearheaded the largest, most durable, and grandest projects, and it is no coincidence given the material, geometric, and physical intuitions of these old-world builders, that the head stonemason was in many ways the proto-architect.

The Romans innovated pozzolana concrete and multiplied the formal capacity and durability of their buildings; scientific innovation, once again adding further complexity to the relationship. Later, the Victorians collected, pondered, and displayed mineral specimens with authors like John Ruskin gloomily appreciating the vanitas of weathered buildings, likening them to weathered mountains. The moderns embraced the 20th century mastery of modern concrete, and despite the pops of travertine, insodoing, essentially sealed the fate of stone as a building material. Science had, it seemed, removed the stonemason from architecture's C-suite for good.

Beyond the broad historical contexts, one can identify, throughout the centuries, two primary veins in the archo-geology discourse: the literal and the metaphysical. The "literal" conversations were more prevalent when architecture was in its infancy and until the demise of stone as structural material. The extraction and physical nature of rocks as masonry units was, for millennia at the forefront of how builders understood both buildings and, but now, however, these conversations are almost completely irrelevant to modern architects. Combined with the high bar-for-entry provided by contemporary scientific lexicons, architects and geologists have come largely out-of-sync in most practical ways. Thus, the "literal" geology conversations have been cordoned off to the scientists.

Contemporary architects, are almost completely concerned -if it all- with the metaphysical aspects of geology. The ways in which architects tend to borrow from geology tend to be similia not verisimilitude, at least not to the degree that bio-philia and electron microscopy of biological samples have directly found their way into architectural practice. That is, with a few exceptions, there appears to be less of a robust nuanced interdisciplinary overlap than one might expect, given the history between the two disciplines.

In *Landform Building*, Stan Allen gathers a wide array of writings on architecture and the lessons it can take from geology. Asserting that "architecture is situated between the biological and the geological – slower than living beings, but faster than the underlying geology," Allen posits a set of guidelines for using literal geological phenomena as a substrate for both physical and metaphysical inspiration (22). With sub-section headings like "Scale – Megaform," and "Atmosphere – Vast Interiors" Allen situates his exploration around the "telescope" scale of geology, leaning toward the realm urban design and emphasizing extreme horizontality as much as towering vertical masses. In this anthology, Allen constructs a useful framework for a contemporary archo-geology discourse that interrogates the physical and phenomenological aspects of geology that can be useful to architectural designers.

1. Pataphysics is the science of imaginary solutions, which symboli cally attributes the properties of objects, described by their virtuality, to their lineaments

In this same spirit of Stan Allen's hybridization of the metaphorical and the literal, this body of research is aimed at furthering both the "microscope" and "periscope" scales of geology, and how they might inform a reinvigorated interest in geological science as relevant -if not requisite- to an enhanced understanding of architecture. Geology and architecture share a common origin, and by that logic, some might argue, a common destiny. In much of contemporary construction practice, stone appears as a veneer or as a post-processing manufactured product such as gypsum. In its most crass application, it is simulated in concrete; a copy of a copy referring to an otherwise obsolete, although nostalgic, nearly bygone material. However, while the rock has fallen all but out of relevance in its previous position, architecture remains integrally tied to the mine and the refinery in evermore complex and "high-tech" ways. Metals and rare-earths are as relevant as ever, and with the shift toward green energy, they have become critical in keeping architectural practice up-to-date with solar panels, batteries, and other integrated technologies. Architects find themselves outside the science and the industry of geology, but inextricably bound to its products.

There may be a benefit, then, for architects to focalize on the scientific nitty-gritty, not to assert themselves back into the role of the stonemason, but to redeploy the physical and metaphysical stuff of science to architectural ends in exhaustive, granular, and scientific detail. To do so requires a great deal of topical reading that tends to challenge the comprehension abilities of the architect, who steps into the role of layperson. In the process, there is the opportunity for a kind of "beginner's mind" or childlike wonder when approaching these otherwise hyper-niche books and articles, a situation where an architect might see something a scientist might only use as mundane data.

For instance, the section drawings, satellite imagery, and geometric theory associated with oil exploration have a rich visual overlap with the interests of architects, despite the connotation. In *Industrial Structural Geology* (2015), a highly specific and proprietary text targeted at geologists who study oil shale, there are a large volume of striking diagrams and satellite composites of the geometric and dynamic phenomena associated with industrial oil drilling. The article "The association of folds fractures and the link between folding, fracturing and fluid-flow during the evolution of a fold," contains a wealth of interesting diagrams, detailing the behavior of rock in terms of stress flows, developable surfaces, and other architecturally translatable phenomena.

Another older scientific text, *Clastic Particles: Scanning Electron Microscopy and Shape Analysis of Sedimentary and Volcanic Clasts* (1984), catalogues a large number of various SEM images of tiny particles of quartz, zircon, and other minerals. These images are objectively beautiful, but are also accompanied by substantial analysis as well as frameworks for quantifying irregularly shaped fragments of material. This book also contains a large number of diagrams, mathematics, and lexicons for analyzing specific shapes. The discussions of the "fractal dimension" as a means of analyzing particles is of particular interest, since it provides a series of adjustable formulas (based on Mandelbrot's) as well as charts depicting how to "calibrate" said dimension.

Enthusiastically touted as "Earth's Most Amazing Rocks" by expert Michael Wise PhD, pegmatites have quickly become the center of the geology research conducted by this survey thus far. Briefly defined, pegmatites are igneous (volcanic) rocks formed of feldspar, quartz, and mica; they are characterized by large grained crystal structures, are primary sources for mining rare earth minerals, and can form large gems of many rare and valuable species. However, these rocks are infinitely more complex and multifarious than one definition can adequately surmise. The local and global variety of pegmatites make them elusive and highly sought-after industrially. Just developing the lexicon for discussing these rocks is a geology education in itself, and possibly the perfect unsung gateway drug for an architect dipping into the field.

Like Michael Wise, this researcher is most enamored with granite pegmatites, which contain alkali feldspar, biotite mica, and quartz, which, as the name suggests, are the same minerals that compose granite – the somewhat inane and ubiquitous rock that still finds its way into modern material finishes (though as Wise points out, sometimes "granite" countertops are actually misidentified pegmatite). These rocks in particular are also responsible for most of the rare and impressive gems found on the planet.

For architecture, the study of granite pegmatites has several implications. First and foremost is the objective beauty of many specimens because of the coarse and often large size of the crystal grains. Second, the interlocking growth pattern of incompatible minerals (those unable to blend with the matrix) which gives rise to the formation of gemstones, is a master-class in packing various geometries in natural but irregular patterns due to the variety. Since large gems form from slow cooling processes there are 4-D elements to the final geometry, and an inherent "elegantly disheveled" planar-yet-organic quality (the likes of which appears often in the culinary world, ie charcuterie boards.

Another aspect of pegmatites that could be of interest is their position as a target for mining and extraction. In his "Ten Commandments of Pegmatites" Wise instructs his audience playfully that "thou should not worship any other rocks before pegmatites" and more emphatically "thou shalt not defile or desecrate any pegmatite, this is just wrong." Though it may seem typical of someone who want to "find a way to be reincarnated" to continue his work on the subject to be so defensive of pegmatites, the assertion is well-founded. These rocks often comprise a matrix that is either ground up to extract lithium or smashed away to loose the precious gems protruding outward. The destruction of the matrix to achieve the gem is a rich and relevant philosophical lens to apply to architecture.

An Autochthonous Architecture, a thesis by former UNCC student Joshua James, proposes an ethos of building using hyper-local materials, such a clay harvested on site. A potential vein of research lies in the exploration of examining and deploying motifs from local rock and mineral samples such as stratification, grain-size, color, and composition, instead of the materials themselves. For example, one might collaborate with a geologist to collect samples from a site or a greater area in order to analyze them in the lab for visual data. Technologies like 3-D scanning and SEM could help to create architectures that mimic the site and setting on a molecular or granular scale, mimicking cleavage planes, species intersections, and weathering patterns. When extrapolated to the heterogenous pegmatite, this idea gains even more depth, allowing for analyzing crystal growth, variety, and modes of intersection between the discreet minerals as they interlock within the matrix.

As displayed in the summary above, this body of research is not particularly concerned with the “faceted gems” or “vast landscape” aspects of geology, but of the diagrammatic, phenomenological, and mathematical richness of the study of geology. Though there may be some overlap with the blobs and digital architectures of the late nineties and early aughts, based on preliminary research, the opportunity for visual innovation based on a deep-dive into the recent decades’ fruits of the geology lab may yet yield an untapped wealth of information that can be directly employed or retrofitted to architectural ends. By focalizing around specific topics like pegmatites, particle analysis, and fold geometry, this body of work hopes to unearth novelty in visual, material, and systemic connections between geology and architecture.

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Mica and Feldspar - Value of the conduit/matrix above the embedded or extruded gemstones (What we crush)* [in search of gems and rare-earth]

Value of Imperfection and diversity

Inflection points/collision zones

Concentration of sulfide minerals

Elegantly disheveled - found specimens as formal inspiration

Structural layering of large crystal *** - bands and section design

Generative/iterative inspiration by observation/(small-scale or photographic)/collection

Toward a Pegmatitic Architecture

Scales of experience

Thematic/Metaphoric substrates for architecture and visual fodder

Interlocking heterogeneity

Asymmetry/serendipity of form

Large crystal formation

Schists Gniess and Metamorphic design

“flow” of material

Stealing from oil barons:

(Industrial Structural Geology) - learning from the “mega-section” diagram

Reclaiming proprietary geologies for restorative architecture