SUGGESTIONS FOR TEACHING MINERALOGY

This is a compilation of references and suggestions for teaching mineralogy. This information is intended to be used with a mineralogy text. Any additions or constructive comments would be appreciated.

Mineralogy allows students to combine information from chemistry, mathematics and physics. The division of mineralogy that is most suited for introductory work is physical mineralogy. Here minerals are identified on the basis of properties exhibited by minerals. This readily lends itself to student envolvement with a minimum of effort or equipment.

Much of physical mineralogy is becoming familiar with terminology. This can be done by association. Using numbered specimens and flip cards the student becomes actively evolved. The student matches a specimen(s) with the appropriate term on a card. After all the specimens have been matched then the term cards can be flipped to show the students the name of the minerals showing the property. This allows students to check their progress as they go.

A few precautions should be brought to the students attention before they start handling and trying to identify minerals. They are: 1) Handle the specimens carefully, they do break and when they do they have to be replaced - IF POSSIBLE. Or, if a specimen will be ruined by a particular test do not do the test. 2) Do not base an identification on only one test. A good identification uses as much information as possible. 3) All the properties given for a mineral may not be seen in a single specimen. So try to look at a number of specimens if possible.

Physical properties can be grouped into as few as five basic categories. 1) COLOR, 2) FORM, 3) HARDNESS, 4) SPECIFIC GRAVITY and 5) SPECIAL PROPERTIES. The following is an outline of these properties with suggestions on presentation to the student:

1) COLOR including streak luster and other visual properties

A) Color

MATERIAL: Numbered study specimens; flip cards; light source

OBJECTIVE: To bring out the difference between 1) true color (idiochromatic) cause by the make up of a mineral and 2) false color (allochromatic) caused by impurities in a mineral. Also to help familiarize students with color as it applies to mineralogy.

TECHNIQUE: Matching

NOTES: Color is diagnostic for most true colored minerals but can be misleading in those showing a range of colors.

B) Streak

MATERIAL: Numbered study specimens; flip cards; streak plates

OBJECTIVE: To teach student how to do a streak test and to become familiar with the terminology and equipment.

TECHNIQUE: Students do streak test then match.

NOTES: Streak plates are unglazed porcelain - that's all. Streak plates can be made from old china or the back side of glazed tile. Watch out for sharp edges, file them down. Clean streak plates as necessary with a household cleanser.

C) Luster

MATERIAL: Numbered study specimens; flip cards; light source

OBJECTIVE: To introduce the student to luster and the associated terminology.

TECHNIQUE: Matching

NOTES: If possible show the necessity of a fresh surface for this test with a specimen of metallic luster that has both a weathered and fresh surface on it.

D) Transparency (diaphaneity) and other visual properties

MATERIAL: Numbered study specimens; flip cards; light source

OBJECTIVE: To acquaint the student with the visual properties and terminology associated with these properties.

TECHNIQUE: Matching

NOTES: These are of little general use, require numerous specimens, but because of their singularity they can be diagnostic if exhibited by the specimen. When acquiring specimens for this section be sure they show the property you want the students to see.

2) FORM

A) From growth, crystal systems

MATERIAL: Paper models

OBJECTIVE: To show students the basic differences in the six crystal systems.

TECHNIQUE: Students build models then describe differences in the forms

NOTES: Wards Natural Science Establishment offers a number of crystal model sets that you could use to expand upon this basic idea. These models are also useful in teaching students how to use a contact goniometer.

B) Decrescence, crystal form
MATERIAL: Large number of “unit cells”
OBJECTIVE: To help the student visualize the relationship of crystal forms within a crystal class and to give a demonstration of Hauy's theory of decrescence.
TECHNIQUE: By varying the stacking arrangement of unit cells various crystal forms, compound or simple can be made.
NOTES: Cubes are easiest to make and work with but other forms do work.

C) Thymol crystals, crystal growth
MATERIAL: Thymol; hot plate; overhead projector; hand lenses
OBJECTIVE: To show students crystal growth.
TECHNIQUE: See attached sheet
NOTES: This experiment can be used to demonstrate crystal growth as well as later in a discussion of rock textures - Caution use in well ventilated area and don't overheat thymol. This can be used with part 2D crystal growing.

D) Crystal growing
MATERIAL: Alum, sugar, salt, etc.; water; glass containers; hot plate
OBJECTIVE: To have the student grow crystals from a solution.
TECHNIQUE: Saturated solutions of chemicals are made then allowed to set and crystals grow. Small seed crystals should be suspended in the solutions to encourage large single crystals to grow.
NOTES: This takes a long time, weeks or months, plan ahead. Common household chemicals can be used. Students can use results of this exercise to experiment with - i.e. describe crystal form, to test for cleavage, determine hardness, etc. This can be used with part 2C - Thymol crystals.

E) Aggregate forms
MATERIAL: Numbered study specimens; flip cards
OBJECTIVE: To acquaint the student with the terminology and forms associated with aggregate crystal growth.
TECHNIQUE: Matching
NOTES:

F) Form, from breaking, 1 cleavage
MATERIAL: Calcite; and or halite; beach sand; hand lens
OBJECTIVE: To demonstrate cleavage and fracture.
TECHNIQUE: Cleave a large piece of calcite or halite, then pass around samples of calcite, halite, and table salt (halite), calcite powder, and beach sand. Have the students discuss the differences or similarities they see. The student will have to use a hand lens to look at the table salt, calcite powder and sand.
NOTES:

G) Form, breaking, cleavage terminology
MATERIAL: Numbered study specimens; flip cards
OBJECTIVE: To help the student recognize cleavage planes and simple forms and the associated terminology.
TECHNIQUE: Matching
NOTES: Paper models may be helpful here, too.

3) HARDNESS
MATERIAL: Numbered study specimens; flip card
OBJECTIVE: To have the student do hardness tests and make the hardness scale.
TECHNIQUE: Student does hardness test, arranges the minerals accordingly, compares results by matching.
NOTES: Hardness is a relative term, and impurities or weathering can give you a false test.

4) SPECIFIC GRAVITY
MATERIAL: Balance; dish with water; thread or twine; numbered specimens; match cards
OBJECTIVE: To teach students how to determine specific gravity by doing the necessary work and simple math.
TECHNIQUE: Student records weight of specimen in air (A) and weight in water (W) then calculates specific gravity by Sp.G. = A/(A-W)
NOTES: Watch out for impurities or mixtures of minerals.

5) SPECIAL PROPERTIES
MATERIAL: Numbered specimens; flip cards
OBJECTIVE: To demonstrate some of the more singular special properties of certain minerals.
TECHNIQUE: Matching
NOTES:

Putting it all together

1. Give a mineral identification test. Try to use specimens that are different from the samples seen by the students, yet still representative of the mineral.

2, Economics
   A Select a mineral and have a student find out how this mineral is used.
   B Have students list minerals applications found in the home or in the classroom.
   C Have the students plot on a graph the changes in use rates of a mineral resource and how much time before known supplies will be exhausted.

3. Conduct a field trip to collect minerals.

4. Work into the study and classification of rocks.

5. Historical mineralogy. Have the students work up a history of:
   A) a famous Mineralogist
   B) Mineralogy for a period of time
   C) a particular mineral resource
   D) a particular mine or quarry or mining area

6. Devise mineral games

example: MOONWALK. Place a container at a table where no students are sitting. The box contains a mixture of materials in fixed proportions. Divide the students into groups to compete against each other. They are to "fly" to the container, land, take samples (use tweezers and a small thimble sized container to put samples in) and return to their base in only 30 seconds.

They will need to plan how they will get there, who will go, etc. Upon return they will analyze what they have and try to determine the percentages present in the box. The team closest to the actual amounts is the winner.

Helps teach students some of the problems in mineral exploration in a contemporary context.

Please direct your comments, corrections and additions to:

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY DIVISION
P. O. BOX 30028
LANSING, MICHIGAN 48909
ATTN: STEVEN E. WILSON

PHONE (517) 373-7860

Using the Overhead Projector to Deminstrate the Growth of Crystals from a Melt

Thymol ($C_{10}H_{14}O$, melting point 125°F) is melted in a petri dish, placed on the overhead projector, seeded with thymol crystals, and observed during crystallization. Crystallization of magma can be simulated under varying conditions by varying the number of seed crystals added.

Crystal growth is a fundamental physical process which often receives inadequate attention in textbooks and laboratory manuals currently in use in secondary school earth science courses. It can, however, be easily and dramatically demonstrated. For maximum benefit to students, the material described below should be presented in the form of a laboratory exercise to be as it is magnified and projected onto the screen. Accretion of new layers of crystalline thymol onto the nuclei is rapid, and the fact that crystal growth takes place as a result of accretion of new material on the crystal faces is easily visible if students watch the formation of distinct growth lines parallel to crystal edges. Various crystalline textures observed in igneous rocks (e.g. coarse-grained equigranular, fine-grained equigranular, and porphyritic) can be reproduced if the way in which seed crystals are added to the melt is varied. The exercise can thus be an ideal introduction to the descriptive study of igneous rocks.

An additional advantage to the demonstration technique is that the teacher is able to ascertain that all the students see and understand how the crystals grow, whereas in the laboratory situation some of the slower students may fail to discover the process by themselves. Perhaps the best technique of all is to have a laboratory hour in which the students themselves attempt to derive generalizations about crystal growth from their own observations and to follow the laboratory with a lecture-demonstration in which the teacher reviews the concepts of crystal growth and uses the overhead projector to point out specifically what he had hoped the students would observe and how they could have used their observations to make a sound inductive generalization.

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_____ LIST OF PUBLICATIONS, ISSUED BY THE BUREAU OF MINES.

_____ MINERAL FACTS AND PROBLEMS.

_____ MINERAL YEARBOOK. Issued annually, Vol. I, Metals and Minerals; Vol. II, Fuels; Vol. III, Area reports; Vol. IV, International area reports.

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DNR/GSD
Steven E. Wilson – 6/1976

Museums in Michigan with rock, mineral, or fossil collections

ALBION
Brueckner Museum of Starr Commonwealth for Boys (517) 629-5593, ext. 36

ANN ARBOR
University of Michigan, Department of Geology and Mineralogy (313) 764-1435
University of Michigan Exhibit Museum (313) 764-0480

BATTLE CREEK
Kingman Museum of Natural History (616) 965-5117

BAY CITY
Jennison Trailside Nature Center (517) 684-3020

BLOOMFIELD HILLS
Cranbrook Institute of Science (313) 645-3210

COPPER HARBOR
Fort Wilkins State Park (906) 289-4215

EAST LANSING
Michigan State University, Department of Geology (517) 355-4626
The Museum, Michigan State University (517) 355-2370

GRAND RAPIDS
Grand Rapids Public Museum (616) 456-5494

HOUGHTON
A. E. Seaman Mineralogical Museum (906) 487-2572

KALAMAZOO
Kalamazoo Nature Center, Inc. (616) 381-1574

LAKE LINDEN
Houghton County Historical Museum Society (906) 296-4121

MARQUETTE
Marquette County Historical Society (906) 226-6821

MILFORD
Kensington Metro Park Nature Center (313) 685-1561

MONTAGUE
Montague Museum & Historical Society (616) 894-6972

MT. PLEASANT
Center for Cultural & Natural History (517) 774-3829

MUSKEGON
Muskegon County Museum (616) 722-0278

NILES
Fort St. Joseph Museum (616) 683-4702

SOUTH HAVEN
Dr. Liberty Hyde Bailey Memorial Museum (616) 637-1358

for annotated list:

U. S. Bureau of Mines
State Liaison Office – Michigan
Room 1121, Commerce Center Bldg.
300 S. Capitol Avenue
Lansing, Michigan 48933

(313) 372-1910 Ext. 681

EQUIPMENT CHECKLIST

Balance	Magnet
Book	Maps
Brush	Matches
Catalog	Metal detector
Chisel	Microscope
Clear coating	Notebook
Compass	Permission
Display space	Raingear
Field guides	Safety glasses
First Aid kit	Safety shoes
Flashlight	Shovel
Gloves	Storage
Hammer	Streak plate
Hand lens	Study specimens
Hard hat	UV light
Hardness points	Water
Knapsack	White paint
Labels	Wrapping paper
Lunch	

THE ROCK COLLECTOR'S CODE OF ETHICS

The following rules were adapted from the Code of Ethics of the Midwest Federation of Mineralogical and Geological Societies. These rules are heartily endorsed by the DNR Geological Survey Division and should be observed at all times when collecting minerals, fossils, and any other materials on public or private lands in Michigan. Lets all enjoy over great natural heritage to the fullest and not spoil it for all who come after.

Respect all property, both private and public. Do not collect on privately-owned land without permission from the owner.

Observe all laws, rules and regulations governing collecting on public lands.

To the best of your ability observe boundary lines of property you plan to collect on.

Do not use firearms or blasting materials in collecting areas.

Do not cause willful damage to fences, signs, buildings, or any other property.

Leave all gates open or closed as you found them.

Build fires only in designated, safe areas, and be certain they are completely extinguished when you leave.

Do not discard matches, cigarettes, or other burning materials.

Fill all excavation holes which are a possible danger to livestock or humans.

Do not contaminate wells, creeks, rivers, ponds, or lakes.

Do not cause damage to collecting material or take home more samples than you can reasonably use. Leave something for the next collector just as the last one left something for you.

Leave all collecting areas devoid of litter, regardless of how found.

On a field trip cooperate with your leader and all those in authority.

Report to the U. S. Forest Service or Michigan Department of Natural Resources any archeological remains, vertebrate fossils, meteorites, petrified wood or other outstanding or unusual mineral or fossil specimens or other material on public lands which you feel should be protected for the enjoyment of future generations and for public educational and scientific purposes.

Observe the “Golden Rule”. Use good outdoor manners and conduct yourself in such a way as to add to the stature and public image of rockhounds and

Appreciate and protect our heritage of mineral resources.

Further hints to the collector

Buy and use a good reference book.

Become acquainted with other collectors in your area.

Encourage organized study and work to improve meetings you attend.

Visit museums and other collector's collections.

Do not destroy specimens you cannot collect.

Do not collect more than a reasonable amount of material from one locality.

Start your collection off general then specialize as you learn.

Keep good written records of your collection.

Plan a cataloging system.

Keep information about the mineral (name, locality, date, how or who collected it, etc.) on cards or in a book and number each specimen to correspond to a catalog entry. Paint a small white rectangle in an inconspicuous place. Print catalog number in ink on rectangle. Cover with a clear protective coating.

Learn how to properly clean and prepare specimens.

Wrap specimens in the field with identification to avoid damage and memory loss.

Allow for proper display and storage of your specimens.

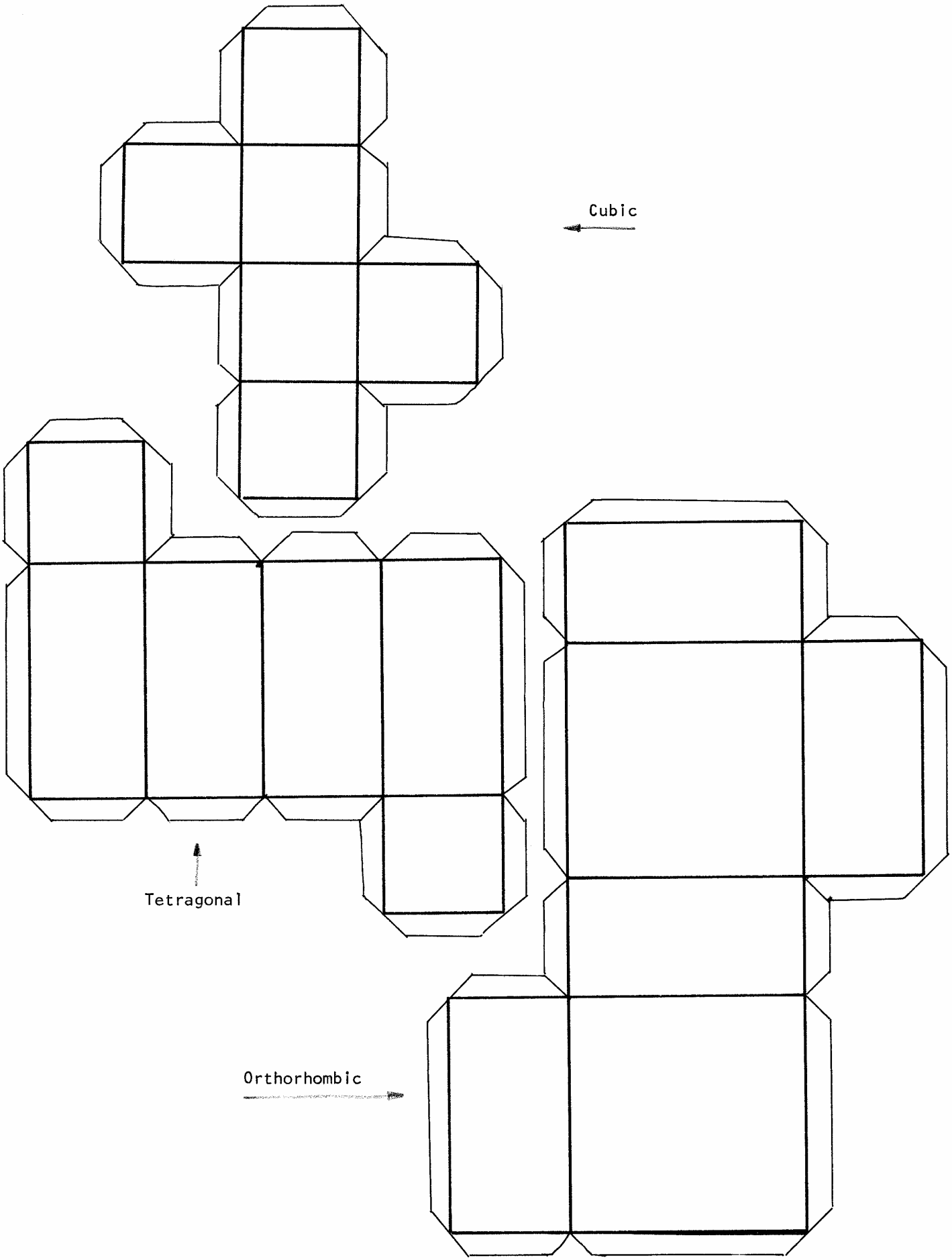
Do not ruin a specimen in your attempts to identify it.

Keep upgrading your collection.

Learn to use a hand lens.

Look but don't touch.

Department of Natural Resources
Geological Survey Division
Lansing, Michigan


Cubic
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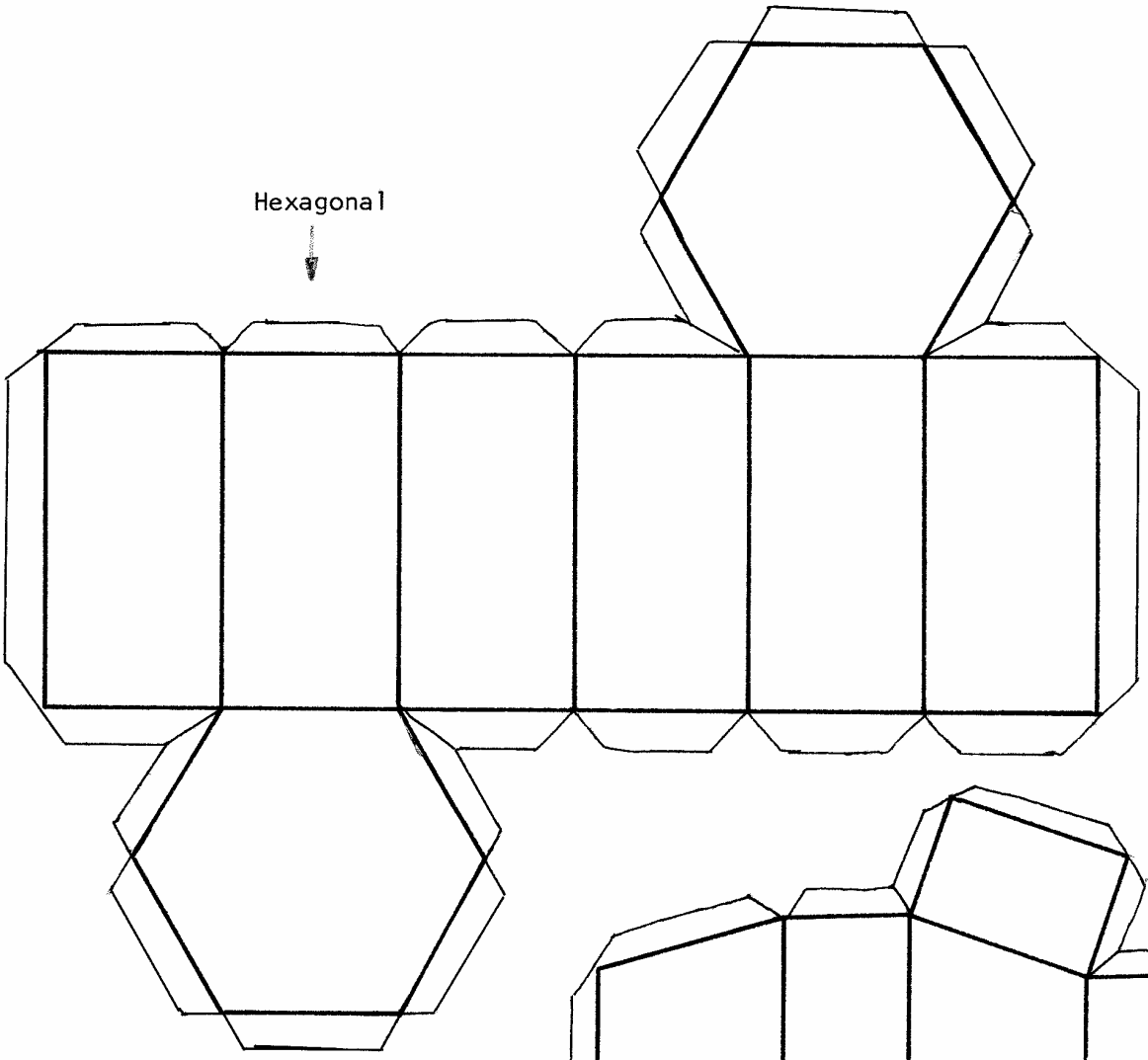
Orthorhombic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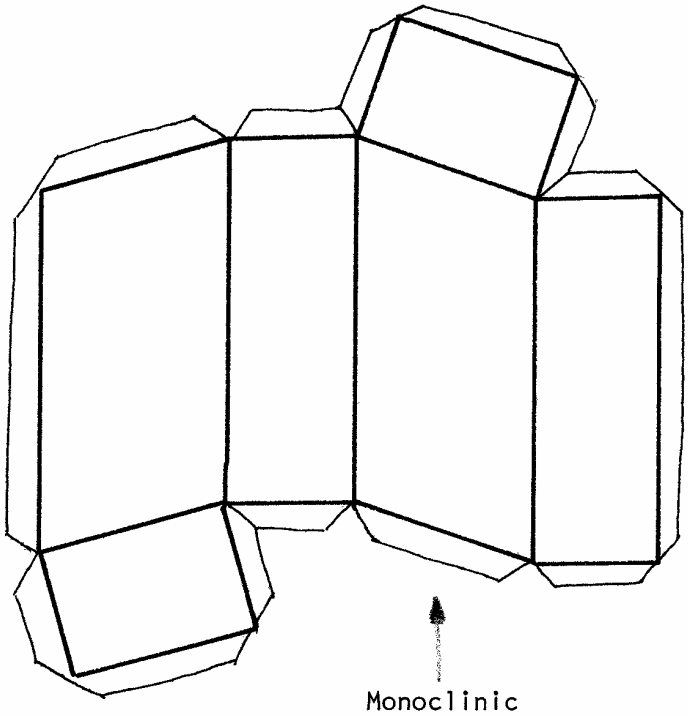
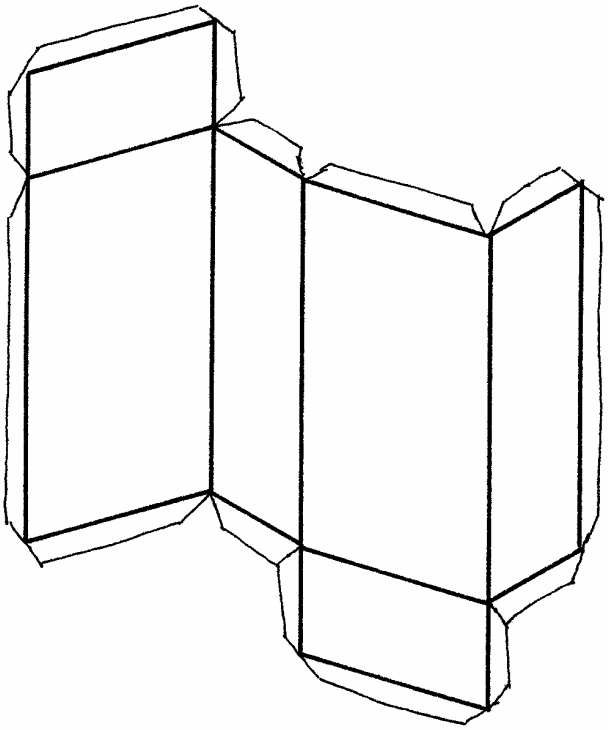

Monoclinic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