CHAPTER

2

Fundamental Concepts

EXERCISES

Exercise 2-1 ORDERING GEOLOGIC EVENTS

Part A — Complete the ordering of geologic events in the four following diagrams. These answers refer to Fig. 2.16 (a, b, c, d).

a. Deposition of units 1-3 and perhaps others; intrusion of dike; erosion; resubmergence and deposition of units 5 and 6 creating a disconformity and nonconformity.

b. Deposition of units 2-7 and perhaps others; folding, faulting, erosion, deposition of units 10-12 creating an angular unconformity.

c. Deposition of units 1-4 and perhaps others; intrusion of batholith; erosion deposition of units 6-8 creating a nonconformity and disconformity; intrusion of dike (or unit 8 could be deposited last).

d. Deposition of units 1-4 and perhaps others; erosion; deposition of units 5-9 and perhaps others creating a disconformity; folding; erosion; deposition of unit 12 creating an angular unconformity; erosion; deposition of unit 14 (glacial till) with resulting disconformity.

Part B — Draw in as many faults as you can find, and then provide a general description for a sequence of geologic events.

See Fig. 2.17. Sequence of events: deposition of sedimentary layers A–E; normal faulting with displacement on left-hand faults greater than that on right-hand faults.

Part C — Draw in the fault and describe a sequence of geologic events. What is the material that appears to hide the fault trace?

See Fig. 2.18. Sequence of events: deposition of sedimentary layers A, B; reverse faulting; slump block covers base of fault trace.

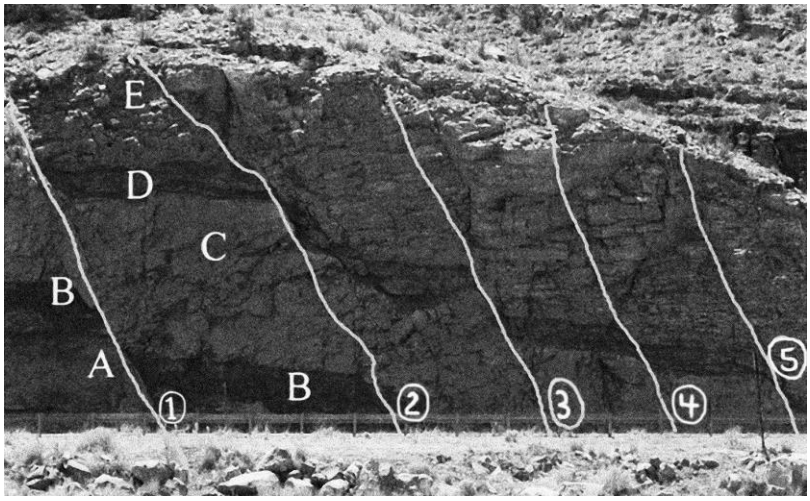

Figure 2.17 Faulted Entrada formation near entrance to Arches National Park

Figure 2.18 Faulted Entrada formation south of Moab, Utah

Part D — Draw in the four primary faults (there are several subsidiary faults). Describe a sequence of geologic events.

See Fig. 2.19. Sequence of events: deposition of sedimentary layers A, B, C, D; normal faulting (displacement on left-hand faults is greater than that on right-hand faults).

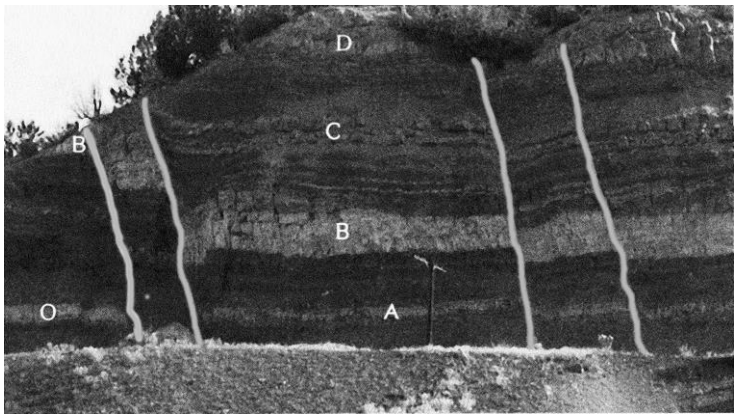

Figure 2.19 Twin Creek formation, Highway 6 near Thistle, Utah

Part E — In Fig. 2.20, an approximated cross-section is superimposed. Using the geologic history of the area provided and Fig. 2.20, describe the geologic sequence of events.

See Fig. 2.20. Sequence of events: deposition of Uinta group; folding of Uinta group; deposition of Madison group; folding of Madison group as faulting occurred 65 million years ago; modern glacial erosion.

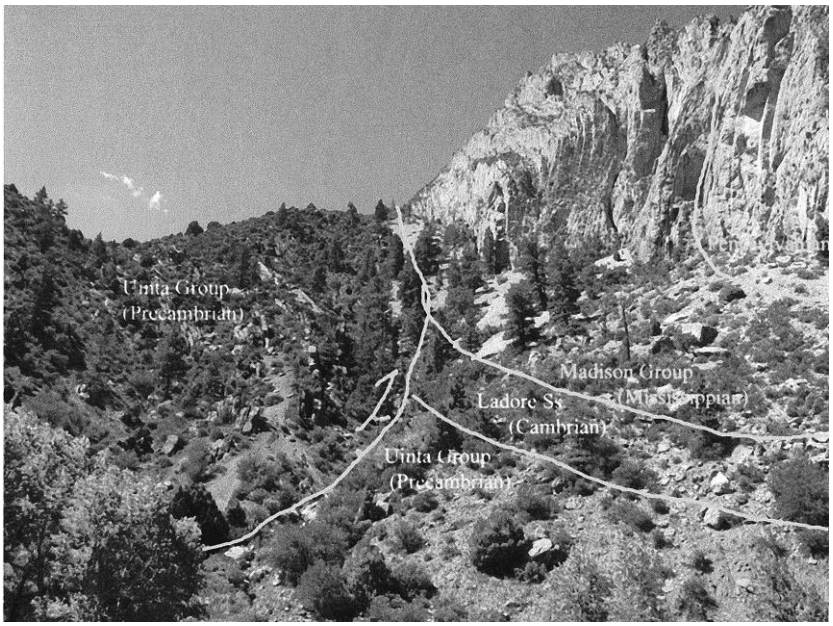

Figure 2.20 Sheep Canyon, Utah

Part F —Complete the ordering of geologic events in the four following diagrams:

(These answers refer to Fig. 2.21 (e, f , g)

e. Deposition of units 1-4, and perhaps others; erosion; deposition of units 6-8, and perhaps others, creating an angular unconformity; folding; erosion; deposition of unit 10-13 creating an angular unconformity; intrusion of laccolith with uplift of units 12 and 13; erosion; deposition of units 18 and 19 with angular unconformity.

f. Deposition of units 1-3, and perhaps others; erosion; deposition of units 5-9, and perhaps others, creating a disconformity; folding; intrusion of dike; faulting; erosion; deposition of 12 and 13 creating an angular unconformity.

g. Deposition of sedimentary units; intrusion of batholith causing arching of sediments; fault on left (normal); intrusion of dike and extrusion of lava flow; fault on right (normal).

These answers refer to Fig. 2.22 (h, i).

h. Deposition of first sedimentary sequence; synclinal folding; erosion; deposition of second sedimentary sequence creating an angular unconformity; tilting of strata; intrusion of first igneous body; erosion; deposition of third sedimentary sequence creating an angular unconformity and nonconformity; intrusion and extrusion of second igneous body.

i. Deposition of units 5-8, and perhaps others; erosion; deposition of units 10 and 11 creating a disconformity; folding into a dome structure; faulting; erosion of dome structure; extrusion of igneous unit 15.

Exercise 2-2 RADIOMETRIC DATING

Use the radiometric decay curve shown in Fig. 2.15 to answer the following:

a. Parent isotope Q has a half-life of 100 million years. Your rock sample has a ratio of 1⁄16 isotope Q and 15⁄16 daughter isotope R. What is the age of your rock? __**400 million years**_____

b. Parent isotope L has a half-life of 20 million years. Your rock sample contains 1⁄4 parent L and 3⁄4 daughter isotope M. What is the age of your rock? **40 million years**

c. Your rock contains 1/2 parent isotope A and 1/2 daughter isotope B. Geochron Laboratories dates the rock specimen at 500 million years old. What is the half-life of isotope A?_**500 million years**_____

d. Your rock contains 1/4 parent isotope S and 3/4 daughter isotope T. Geochron Laboratories dates the rock specimen at 200 million years old. What is the half-life of isotope S? Geochron has also told you that one of its lab technicians split the rock in half and accidentally crushed part of it and lost it down the sink drain. Does this affect the dating of your rock specimen?

100 million years. No, the proportion of parent to daughter would not change.

Fig. 2.26 shows the decay curve for a specific isotope X. Refer to the curve and answer the following questions:

e. If a rock is 100 million years old, what percentage of isotope X is present?

About 71%

f. If 35% of isotope X is present in a rock, what is the rock's age?

About 300 million years

g. If a rock is 400 million years old, what percent of the daughter, isotope Y, is present?

About 75%

Exercise 2-3 MOHAWK VALLEY, NEW YORK

a. Place all of the geologic units in order according to age, starting with the youngest: _**Osc**__, __**Oc-Osh**_, __**Otbr**___, __**Ob**_____, ____**Css**__, __**PreC**___ (oldest)

b. If the unit Css is a fine-grained sandstone, and the Pre C units are metamorphic gneisses, what kind of surface exists between these two units?

_____**nonconformity**_____.

c. Assuming that all of the faulting west of Schenectady occurred at the same time in the cross-section, what is the age of that faulting? (circle one)

1. before Css 2. before Osh 3. after Otbr 4. after Osc

Exercise 2-4 CHESTER VALLEY, PENNSYLVANIA

a. Name all of the Paleozoic units.

___**Sellers, Conestoga, Wissahickon**_____

b. Along the north side of the Chester Valley, some of the Newark beds are mapped. An obvious unconformity exists between these Triassic beds and the underlying units. What type(s) of unconformity exist along the old, erosional surface?

No unconformity (over gneiss); Angular unconformity (over layered units)

c. What evidence shows that the Chester Valley area has undergone compression and metamorphism in the geologic past?

Folding of layered rocks, reverse faulting, presence of gneiss, quartzite, marble, phyllite, schist

Exercise 2-5 SEQUENCE OF RADIOMETRIC EVENTS IN NEW MEXICO

a. Using Figs. 2.25 and 2.26 determine the following:

(1) The date of metamorphism of the schist _**438**_ (million years)

(2) The date of the intrusion of A. _**350**_ (million years)

(3) The date of the intrusion of B. _**50**__ (million years)

(4) The half-life of isotope X. _**200**_ (million years)

(5) What is the age of beds 1 to 4? _**Sil-Miss**__ (periods) (See the Geologic Time Chart, inside back cover.)

(6) What is the age of beds 5 to 9? **Miss-Tert (Eoc.)**__ (periods).

(7) Bed 10 could not be any older than _**Tertiary (Eocene)**__ (period).

b. Write a brief narrative description of the geologic history for the cross-section.

Silurian: metamorphism of schist

Silurian-Mississippian: deposition of units 1-4, and perhaps others

Mississippian: intrusion of Dike A, folding

Mississippian-Eocene: erosion

Mississippian-Eocene: deposition of units 5-9, and perhaps others, creating an angular unconformity

Tertiary (Eocene): tilting

Tertiary (Eocene): deposition of units 10-13 creating an angular unconformity

Modern erosion

Exercise 2-6 INTERPRETING THE GEOLOGIC HISTORY OF THE GRAND CANYON

a. What is the name of the oldest rock unit in the cross-section?

Vishnu schist

b. Which is older, the Zoroaster Granite or the Grand Canyon Supergroup?

Zoroaster granite

c. For the rocks exposed in the Grand Canyon, number each of the unconformities present and label its type. For each of these unconformities, list any geologic systems that may be missing and make a calculated estimate as to how much geologic time (in years) is missing. (Use the Geologic Time Scale, inside back cover.)

1. **Vishnu-GC Supergroup: Precambrian, no estimate**
2. **GC Supergroup-Tapeats: Precambrian to Cambrian, no estimate**
3. **Muav-Temple Butte: Cambrian to Devonian, at least 73 million years**
4. **Redwall-Supai: parts of Miss. and Penn. missing, no estimate**
5. **Kaibab-Cedar Mt. Group: parts of Permian and Triassic missing, no estimate**

d. What is the name of the youngest Precambrian unit shown in the cross-section?

Grand Canyon Supergroup

e. List the units that were deposited during the Paleozoic era.

Tapeats, Bright Angel, Muav, Temple Butte, Redwall, Supai, Hermit, Coconino, Toroweap, Kaibab

f. What is the youngest unit of rocks shown in the cross-section?

Cedar Mt. Group, Cretaceous

g. Based only on the evidence in the cross-section, during what geologic period did the Colorado River begin to carve the Grand Canyon?

After the Cretaceous

h. In brief narrative form, describe the geologic history of this region beginning with the Precambrian and ending with the Cretaceous. Be as detailed as the evidence permits. (Use a sheet of notebook paper.)

PRECAMBRIAN: formation of Vishnu schist; intrusion of Zoroaster granite; erosion; deposition of Grand Canyon supergroup; folding; faulting; erosion

PALEOZOIC: deposition of Tapeats, Bright Angel, Muav; erosion; deposition of Temple Butte, Redwall; erosion; deposition of supai, Hermit, Coconino, Toroweap, Kaibab; erosion

MESOZOIC: deposition of Cedar Mt. Group

POST-MESOZOIC: erosion of modern canyon

Exercise 2-7 INTERPRETATION OF THE VALLEY AND RIDGE PROVINCE IN NORTHWESTERN GEORGIA

a. There are two faults in the cross-section. What type are they? Cite your evidence.

Reverse faults because the hanging wall has moved up over the footwall

b. Project the Silurian and Devonian strata from Lookout Mountain to Taylor Ridge

(1) Circle the correct structure:

(a) syncline

(b) breached anticline

(c) monocline

(d) graben

(2) From the available evidence, what is the earliest geologic period this structure could have formed?

After Pennsylvanian time

c. The Pennsylvanian rocks form a conspicuous ledge-forming stratigraphic unit at the top of Lookout Mountain. Why are these rocks more resistant to erosion than others in the cross-section?

Pennsylvanian rocks are sandstones, most likely with a high quartz content, which is resistant to chemical weathering.

d. What type of unconformity is found here?

Disconformity

Exercise 2-8 TEN MILE RIVER MINING DISTRICT, COLORADO

Intrusion	**% Parent X**	**Age**
EM	83%	**50 MY**
LP	76%	**80 MY**
R	60%	**150MY**
GN	xxxx	1.8 billion years

a. Using the above radiometric ages, superposition, and cross-cutting relationships, determine the relative age relationships for the rock units present in Fig. 2.18. Enter the symbols in the correct space on the cross section.

See Fig. 2.30

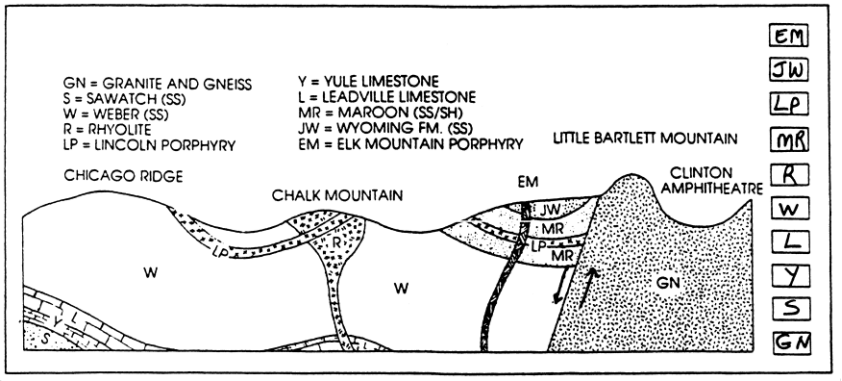

Figure 2.30 Ten Mile River Mining District, Colorado

b. Using Fig. 2.18, list the types of folds and faults present in this cross-section. Describe the forces involved.

Anticlines and synclines: compression

Normal fault: tension

c. The Lincoln Porphyry intrudes the Maroon Formation along a bedding plane. What is the name for such a concordant intrusion?

Sill

d. From the information given, how can you determine the age relationship between the Elk Mountain Porphyry and the fault?

Cannot determine the relationship because they do not cut across each other in this area

e. Write a brief geologic history of this area.

Intrusion of GN

Deposition of S, Y, L, W

Intrusion of R

Deposition of MR

Intrusion of LP

Deposition of JW

Intrusion of EM (or vice versa)

Normal fault

Modern erosion

Exercise 2-9 INTERPRETATION OF THE GULF OF SUEZ

a. What types of unconformities are shown in Fig. 2.32?

Nonconformity over granite; disconformity over Permian; angular unconformity over Cretaceous on top of horsts

b. Why do the faults seem to terminate within the thick layer of evaporites?

Incompetent evaporites flow and adjust during the faulting.

c. What geologic events have occurred in this area, in what sequence, and during which geologic periods or epochs? Discuss briefly.

Granite; erosion; deposition of Permian sandstone; erosion; deposition of Cretaceous shale and limestone, Paleocene shale with sandstone lenses; normal faulting and erosion from top of horsts; Eocene-Oligocene deposition of coarse sandstone; Miocene deposition of evaporites; reactivation of some faults; deposition of Pliocene-Quaternary sandstone and limestone

Exercise 2-10 SUBSURFACE PAKISTAN

a. (1) What type of faulting is found in the Mesozoic sediments?

Normal faulting

(2) What force produced this faulting?

Tensional stress

b. Did the faulting episode end before or after the deposition of the Paleocene sediments? Cite your evidence.

Before; Paleocene sediments are undisturbed.

c. (1) What type of unconformity exists between the Mesozoic-Paleocene strata and the Pliocene sediments?

Angular unconformity

(2) Approximately how many million years are missing in this unconformity? (Refer to Geologic Time Scale, inside back cover.)

49.5 million at least

d. Write a brief geologic history of this area.

Jurassic and Cretaceous: deposition of sandstones and shales

Cretaceous: faulting

Paleocene: deposition of shales and limestones

Paleocene-Miocene: erosion

Pliocene: deposition of silty sandstone

Post-Pliocene: development of soil

Exercise 2-11 GEOLOGIC CROSS SECTION AT BISBEE, ARIZONA

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a. Using Fig. 2.34, examine the cross-section and determine the superpositional relationships among the rock units present. Enter the symbols for the rock units in the stratigraphic column to the right of the figure.

See Fig. 2.34

b. What type of faults are evident in the area of the cross section? What forces were involved in producing them?

Normal faults; tensional forces

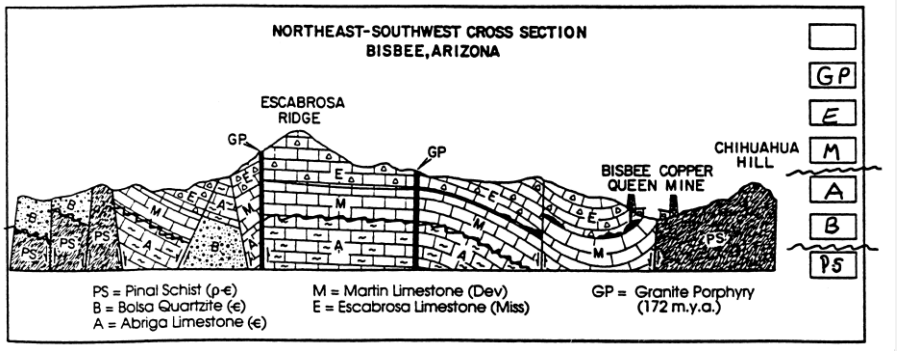

Figure 2.34 Cross section, Bisbee, Arizona

c. What stratigraphic relationship probably exists between the Pinal Schist and the Bolsa Quartzite?

Nonconformity

d. List and name the types of unconformities in this cross-section and determine the missing periods of geologic time. (Use the Geologic Time Scale, inside back cover.) Add the unconformity symbol to the cross-section in the appropriate places.

Ps-B: nonconformity, no estimate

A-M: disconformity; Ordovician and Silurian missing

e. Why does limestone create hills in this desert area of Arizona?

Limestone resists weathering in an arid climate.

f. During which geologic period was the granite porphyry intruded into the Bisbee area?

Jurassic

g. What are the host rocks for the various copper mines?

Limestones

h. The hot copper-bearing fluids penetrated the crust toward the surface. What rock type was preferentially replaced by these fluids in the Bisbee Queen mine area?

Limestones replaced along fault lines and bedding planes

i. Determine the geologic history of this area.

Precambrian: metamorphism of Pinal schist; erosion

Cambrian: deposition of Bolsa quartzite (as sandstone) and Abriga limestone; erosion, Ordovician and Silurian missing

Devonian: deposition of Martin limestone

Mississippian: deposition of Escabrosa limestone; erosion, Pennsylvanian through Triassic missing

Jurassic: intrusion of granite porphyry

Modern erosion