GEOL 3442 Sedimentology and Stratigraphy
Laboratory 2
Siliciclastic Sedimentary Rocks

Purpose: In this exercise, you will examine samples of various siliciclastic rocks in order to become more familiar with concepts of provenance, and to analyze certain aspects of rock texture and composition.

Method: The exercise consists of four parts. For Part I, you will study conglomerate samples to determine aspects of transport and provenance. For Part II, you will complete similar procedures as completed in Part I, but here concentrating on sandstone features. In Part III, you will describe and classify mudstone. In Part IV, you will use the petrographic microscope to address questions of provenance.

Part I
Examine two of the conglomerate specimens and determine the following:
1) Using the comparison chart for visual estimation of percentage composition, determine the percentage of the rock that consists of gravel (grains >4mm in intermediate diameter).
2) Determine the composition of the gravel-size grains and calculate the abundance of each. Percentages can be determined by identifying all the grains in a particular area, then estimating percentages with the appended visual estimation chart.
3) Using the following table, determine the degree of mineralogic maturity of each conglomerate sample as reflected by gravel composition.

Percent Quartz, Metaquartz, and Chert	Mineralogical Maturity
99-100%	Supermature
95-99%	Mature
75-95%	Submature
0-75%	Immature

4) Using Power's roundness scale, determine the average roundness of gravel in each compositional group. In other words, how are roundness and composition related.
5) Using the sorting-image chart, determine the textural maturity of gravel-sized material in each sample.
6) Using information derived from 1-5, determine for each sample:
   a) Relative distance of transport, according to the following table:
      Short - Local derivation (poor rounding, poor sorting)
      Intermediate - Up to approximately 10 miles (moderate rounding, possibly good sorting)
      Long - More than 10 miles (well rounded, possibly very good sorting)
   b) Whether or not recycling may have taken place. Explain your reasoning.
   c) Probable rock types in the source area or explanation why this can not be assessed from the sample.
   d) Classify this rock according to Pettijohn, 1975. Pg 150

Part II

In this part of the exercise, you will examine hand specimens of some common sandstone types, and classify each one according to textural and compositional features. For each sample, you will:

A. determine the rock texture,
B. determine the composition of grains,
C. determine the nature and general composition of interstitial material,
D. classify the rock.

Procedure:

1) Select two sandstone samples.
2) Using your size analysis card(s), determine the average grain size of each sample.
3) Using the sorting image chart, determine the sorting of grains in each sample.
4) Using Power's roundness scale, estimate the average degree of grain roundness (or give a range or roundness) in each sample.
5) Determine the composition of principal framework grains (i.e. quartz and chert, feldspar, and unstable rock fragments) for each sample. Percentage of each component can be estimated by means of the attached visual estimation scale.
6) Determine whether or not the rock contains interstitial cement or matrix, the approximate percentage of such material, and whether this material is carbonate (acid test), siliceous (nail), or clay (soft, nonvitreous, no reaction to acid).
7) Using your knowledge of sandstone classification, and the McBride (1963) classificatory chart, give each rock an appropriately descriptive name. For example: Medium- to coarse-grained, poorly sorted, subangular to subrounded arkose.
8) Offer a brief diagenetic history of the sample.

Part III

In this part of the exercise you will describe and classify three mudstone samples.

Procedure:

1) Select three mudstone samples.
2) Determine the color of the sample.
3) Determine the composition of the sample. Rub or chew a small portion of the sample to determine if the sample is gritty (0-32% clay), loamy (33-65% clay), or slick (66-100% clay).
4) Determine the degree of induration according to the following scale:

Soft, easily disaggregated	Nonindurated
Firm, but can be disaggregated with little effort	Poorly indurated
Firm, difficult to disaggregate	Moderately indurated
Hard, can not be disaggregated by hand	Well indurated

5) Assess whether the sample is best considered fissile or blocky
6) Classify the sample according to Potter, et al., 1980 pg. 157
7) Offer a potential depositional environment for each sample. Support your answer. (Fissility is generally considered an aspect of marine rock.)

Part I Conglomerates

Sample Identification and Location:____________________________________

Percent Gravel in the Sample:_________ Classification_______________________

Pebble Composition	%	Roundness 0 1 2 3 4 5 6	Average Roundness

Mineralogic Maturity____________ Sorting____________

Textural Maturity____________ Transport Distance_________

Comments:

Sample Identification and Location:____________________________________

Percent Gravel in the Sample:_________ Classification_______________________

Pebble Composition	%	Roundness 0 1 2 3 4 5 6	Average Roundness

Mineralogic Maturity____________ Sorting____________

Textural Maturity____________ Transport Distance_________

Comments:

Part II Sandstone

Sample # ______________

Size Range of Grains _________________ Average Grain Size _________________

Sorting Image Estimation (Phi value) ________________________

Range of Roundness _______________ Average Roundness Estimate ___________

Grain Composition % From Estimation

Quartz and Chert ____

Feldspar ____

Rock Fragments ____

Type of Interstitial Binding Material ______________________________

Classification and Descriptive Name ______________________________

____

Diagenetic History:

Sample # ______________

Size Range of Grains _________________ Average Grain Size _________________

Sorting Image Estimation (Phi value) ________________________

Range of Roundness _______________ Average Roundness Estimate ___________

Grain Composition % From Estimation

Quartz and Chert ____

Feldspar ____

Rock Fragments ____

Type of Interstitial Binding Material ______________________________

Classification and Descriptive Name ______________________________

____

Diagenetic History:

Part III Mudstone

Sample #________

Sample color________________________

Composition________________________

Degree of Induration____________________

Fissile vs Blocky Fabric____________________

Classification__________________

Depositional environment:

Sample #________

Sample color________________________

Composition________________________

Degree of Induration____________________

Fissile vs Blocky Fabric____________________

Classification__________________

Depositional environment:

Sample #________

Sample color________________________

Composition________________________

Degree of Induration____________________

Fissile vs Blocky Fabric____________________

Classification__________________

Depositional environment:

Part IV

For this part of the exercise, you will count and identify grains in 2 petrographic thin sections using a polarizing microscope that has a mechanical stage.

Procedure:

A. The Petrographic Microscope.

This instrument has many knobs, dials, screws, and levers. You will need to use only the following:

1) Objective lenses
2) Focusing knobs
3) Analyzer

Do not change or try to adjust any other parts of the microscope.

B. Point counting.

1) Start in the upper left corner of the section. Mark your starting place.

2) Make a vertical traverse, counting a point at each click. Classify whatever rock constituent is directly below the intersection of the cross-hairs, and assign it to the proper category. Don't count holes or cement.

For sample A, the categories are:

1) Quartz + Chert
2) Feldspar
3) Rock Fragments*
4) Matrix
5) Other

* Rock fragments composed of quartz and feldspar are counted as quartz and/or feldspar, not rock fragments

For sample B, the categories are:

1) Non-undulatory Quartz*
2) Undulatory Quartz
3) Polycrystalline Quartz+ (2-3 crystals per grain)
4) Polycrystalline Quartz (>3 crystals per grain)
5) Matrix
6) Other

* If the entire grain goes to extinction inside of 5^0, the grain has a non-undulatory extinction. Otherwise, extinction is undulatory.

+ If two or more segments of a grain on either side of a sharp boundary go to extinction over 5^0 apart, the grain is polycrystalline

3) Move the slide horizontally 5 clicks (or more) to the right, make a vertical traverse upward, and so on until you have counted the proper number of points (200).

4) Try to space the traverses so as to cover the entire slide. You will tally about 12 to 16 points per traverse. Thus, if you need 200 points, you should want about 12 to 18 traverses. If the slide is about 25 mm long, the traverses should be 1 1/2 to 2 mm apart.

C. Requested data.

Fill out the attached data sheet and answer all questions.

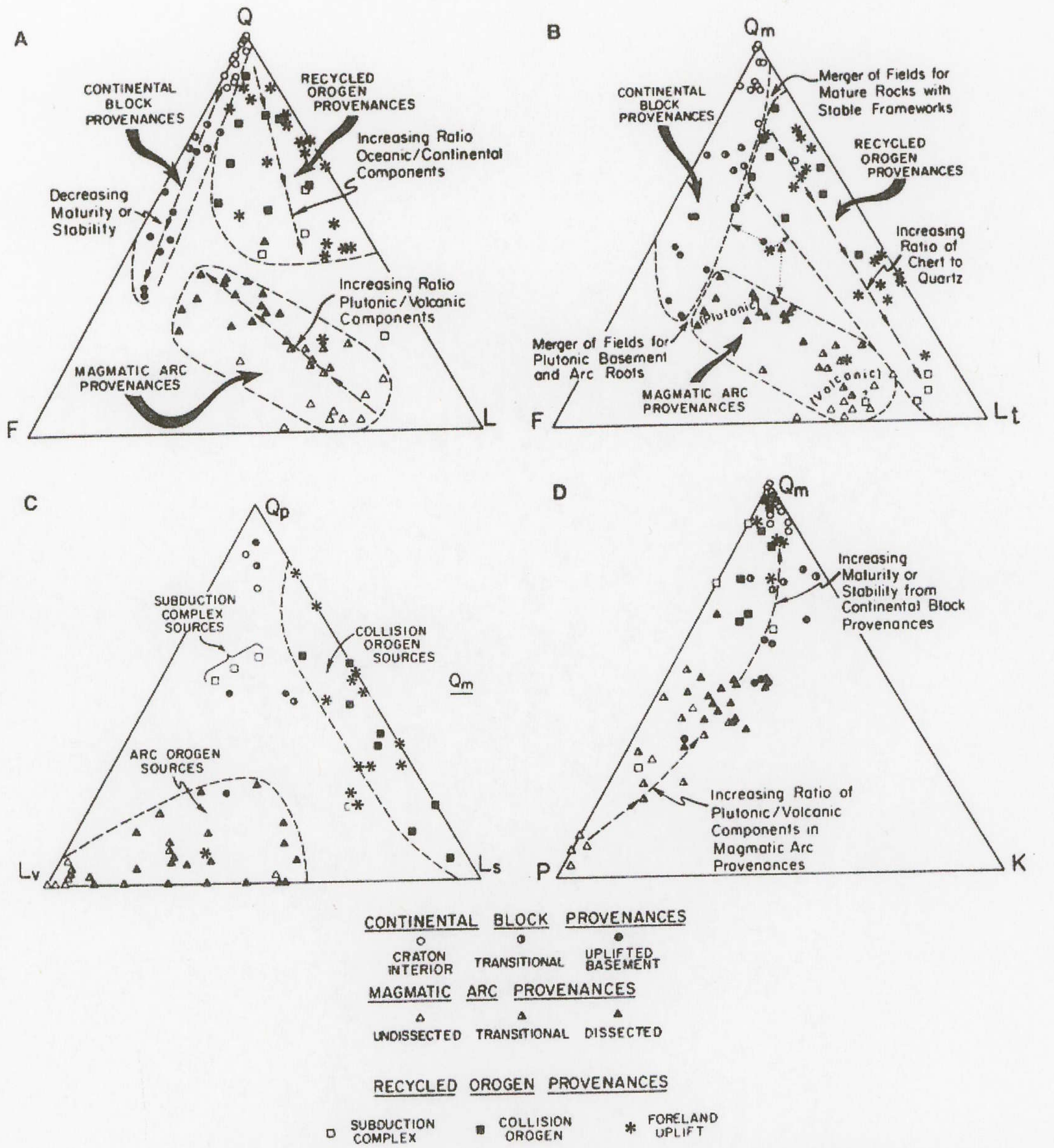

FIGURE 7.14 Four triangular plots showing mean framework modes (sand-size particle composition) for selected sandstone suites derived from different types of provenances: (A) QFL plot, (B) Q_mFL_t plot, (C) $Q_pL_vL_s$ plot, (D) Q_mPK plot. Q is total quartz, including monocrystalline (Q_m) and polycrystalline (Q_p) varieties, F is total feldspar grains, P is plagioclase feldspar grains, K is K-feldspar grains, L_t is total rock fragments, including stable quartzose (Q_p) and unstable (L) varieties, L_v is volcanic-metavolcanic rock fragments, and L_s is sedimentary-metasedimentary rock fragments. (After Dickinson, W. R., and C. A. Suczek, 1979, Plate tectonics and sandstone composition: Am. Assoc. Petroleum Geologists Bull., v. 63. Figs. 1–4, pp. 2171, 2172, reprinted by permission of AAPG, Tulsa, Okla.)

Part IV Point Counting

Slide A

<u>Constituents</u> <u># Points</u> <u>Relative %</u>

Quartz + Chert____________________

Feldspar____________________

Rock Fragments____________________

Matrix____________________

Other____________________

Rock Classification (McBride, 1963)____________________

Identify at least two features of the sample that are a direct result of diagenesis.

____

____

Indicate the most likely tectonic setting for provenance according to Dickinson and Suczek, 1979.____________________

Identify at least two potential sources of error which must be compensated for when using the Dickinson and Suczek (1979) method.____________________

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Identify at least one depositional event which could have altered the original sample to such a degree that even a pristine sample would not yield the correct provenance by the Dickinson and Suczek (1979) method.____________________

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Slide B

<u>Constituents</u> <u># Points</u> <u>Relative %</u>

Non-undulatory Quartz____________________

Undulatory Quartz____________________

Polycrystalline Quartz (2-3 grains)____________________

Polycrystalline Quartz (>3 grains)____________________

Matrix____________________

Other____________________

Rock Classification (McBride, 1963)____________________

Determine the dominate rocks in the source area as argued by Basu, et al, 1975.

____

Identify at least two situations, depositional or diagenetic events, or sampling conditions which could render this method inaccurate.____________________

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TERRIGENOUS ROCK DESCRIPTIONS

Sample #____________

Color: Induration:

Textural Features

Packing: Porosity: Grain orientation:

Overall: Gravel %___________Sand % _____________Mud % _____________

Grain size:

Sorting:

Sphericity: Rounding:

Textural maturity:

Composition

Quartz %____________Feldspar %__________Rock fragments %___________

Rock Fragment Types: IRF %_________MRF %_____________SRF % _____________

Other Terrigenous Minerals (% and type):

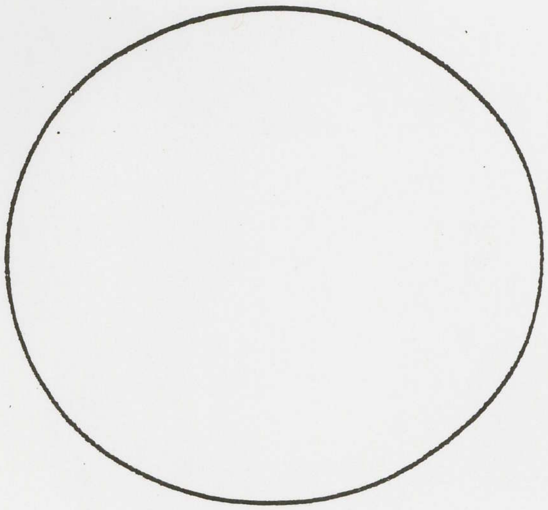
Mineralogical maturity: Cement:

Compositional Name ____

Rock Name:____

Sedimentary Structures:

Interpretation:



TERRIGENOUS ROCK DESCRIPTIONS

Sample #____________

Color: Induration:

Textural Features

Packing: Porosity: Grain orientation:

Overall: Gravel %____________ Sand % _____________ Mud % _____________

Grain size:

Sorting:

Sphericity: Rounding:

Textural maturity:

Composition

Quartz %____________ Feldspar %__________ Rock fragments %____________

Rock Fragment Types: IRF %_________ MRF %_____________ SRF % _____________

Other Terrigenous Minerals (% and type):

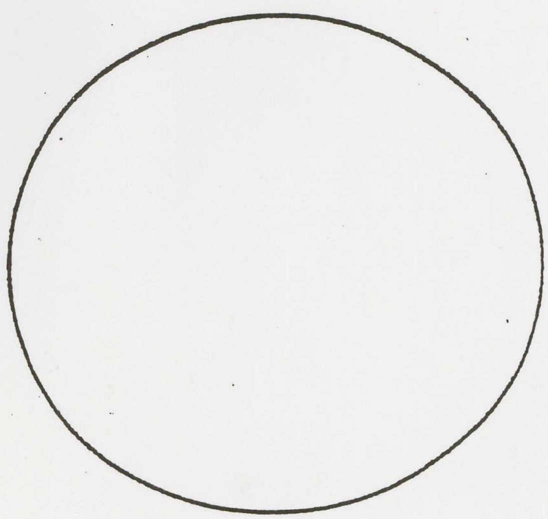
Mineralogical maturity: Cement:

Compositional Name ____

Rock Name:____

Sedimentary Structures:

Interpretation:



TERRIGENOUS ROCK DESCRIPTIONS

Sample #____________

Color: Induration:

Textural Features

Packing: Porosity: Grain orientation:

Overall: Gravel %____________ Sand % ____________ Mud % ____________

Grain size:

Sorting:

Sphericity: Rounding:

Textural maturity:

Composition

Quartz %____________ Feldspar %____________ Rock fragments %____________

Rock Fragment Types: IRF %__________ MRF %____________ SRF % ____________

Other Terrigenous Minerals (% and type):

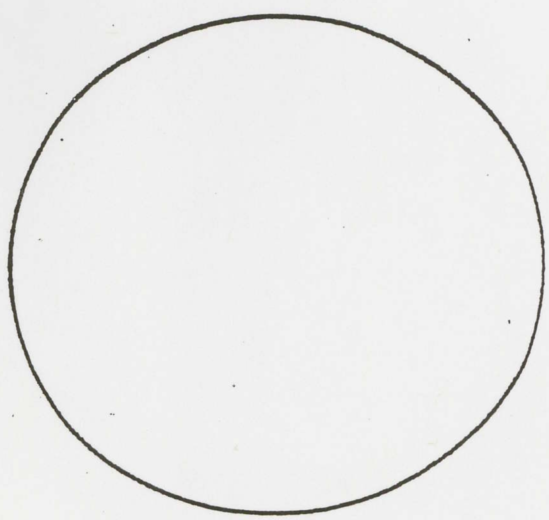
Mineralogical maturity: Cement:

Compositional Name ____

Rock Name:____

Sedimentary Structures:

Interpretation:



TERRIGENOUS ROCK DESCRIPTIONS

Sample #____________

Color: Induration:

Textural Features

Packing: Porosity: Grain orientation:

Overall: Gravel %____________Sand % _____________Mud % _____________

Grain size:

Sorting:

Sphericity: Rounding:

Textural maturity:

Composition

Quartz %____________Feldspar %___________Rock fragments %____________

Rock Fragment Types: IRF %_________MRF %_____________SRF % _____________

Other Terrigenous Minerals (% and type):

Mineralogical maturity: Cement:

Compositional Name ____

Rock Name:____

Sedimentary Structures:

Interpretation: