

SIEVING FOR CLAST SIZE – Teacher’s Guide

ABSTRACT: Students take samples from two different geological layers and sieve for clast size mass data. They will also make sketches of some of the clasts and describe the rounded versus angular aspects in each of the formations. Students then prepare a histogram showing the percentages of clast size mass distribution in each formation. These activities engage the students in multiple learning modalities and help build teamwork.

GRADE LEVELS: 7th – 12th

CLASS TIME NEEDED: Three 50-minute class periods will be needed depending on students’ abilities.

Day 1 – collect clasts from both formations and sieve out sand.

Day 2 – sieve out pebbles less than 1 cm, sort and fill out data tables

Day 3 – sketch, describe, histograms and analysis questions

OBJECTIVES: Students will:

Collect and sort clast samples from two geological formations.

Describe the differences in the samples with both descriptive words and drawings.

Quantitatively analyze the differences of the clast samples by preparing a histogram, which shows the percentages of clast size and type distribution in each formation.

Draw conclusions on the predominant forces of nature active in shaping the clasts in each of the formations and support their conclusions with their data.

NEW MEXICO STATE STANDARDS: See Appendix.

MATERIALS:

For each group of three or four:

Shovel or hand trowel

Two 5-gallon buckets, labeled ‘Ancha’ and ‘Tesuque’

2 or 3 different sizes of sieves

Rulers with a metric scale

Colored pencils

Graph paper

BACKGROUND:

Clast - Pertaining to a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported some distance from their places of origin. (2) An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering (disintegration) of a larger rock mass.¹

In this activity, the students will collect raw data for interpretation, much as geologists actually do in the field. The activity takes students through the stages of scientific inquiry: collecting data, interpreting the data and drawing conclusions.

In preparation for the activity, the teacher needs to locate and identify two geological formations that are within walking distance of the classroom. Alternately, the teacher could collect several buckets of unsieved material from two different formations and bring them to the school.

In the Arroyo Chamiso on the grounds of Santa Fe High School, the Ancha and Tesuque Formations are exposed. These are both part of the Santa Fe Group, with the Ancha overlying the older Tesuque. The Tesuque Formation is composed of conglomerates, sandstones, and mudstones with locally preserved pumice beds. It was deposited as ancient stream beds and channels, floodplains, alluvial fans and windblown deposits.² The Tesuque beds are primarily reddish sandstones tilted 14 degrees down to the west.⁵

The Ancha formation was deposited by streams draining the rugged Sangre de Cristo Mountains of previous times and is composed of silty sands and gravels ranging from pebbles to large boulders. The Ancha also contains layers of tephra from the explosions of the Cerros del Rio and Jemez volcanic fields.^{4,5} The Ancha Formation is 1.25 to nearly 3 million years old and is as much as ten times as permeable as the more consolidated and cemented Tesuque Formation. Common colors of the Ancha range from brownish yellow, yellowish brown and light yellowish brown to very pale brown.³

Much of the city of Santa Fe is built on the Ancha Formation, while the Tesuque Formation is usually only visible in arroyos or railroad cuts. The Ancha Formation will be easier to collect first as it is not as cemented.

TIPS FOR ENTIRE CLASSROOM PARTICIPATION:

Divide the class into groups and give each group a set of materials. Assign one member of the group to be the liaison with the teacher in order to insure that the raw materials are collected from the right spots. You may have students pair up, then you pick the pairs that work together. In that way, you can pair high and low achievers and students still have some choice of whom they work with. Let students know that this is a test of how well they can work together and will determine if they work together during the following activities. Point out that real scientists *do* collaborate together to do research – besides, it's more fun!

PROCEDURE:

1. After dividing the class into working groups and assigning materials, walk to the arroyo to collect the Formation samples.
2. Point out one of the formations to the class. Give the class instructions for collecting the sample by demonstrating the technique for breaking off pieces of the formation.
3. Instruct each group where to collect their sample, and using the bucket labeled “Ancha”, collect a full bucket of the Ancha Formation. Have students use a sieve to let the sand fall through. This sand can be discarded.
4. When everyone is finished collecting the first formation, move to the second formation and have each group collect a full bucket of the Tesuque Formation in the bucket labeled “Tesuque”. Again, have them sieve to let the sand fall through.
5. Return to an outdoor location near your classroom where the sieving can take place. If necessary, have students break apart loose sandstone clumps to get the gravel out.
6. Use the larger sieve to separate pebbles from gravels and larger rocks. Hardware cloth that is ½” works well.
7. Separate the gravels from the larger rocks with a sieve or by hand sorting using a ruler with a metric scale. The larger clasts can be sorted into groups of 5-10 cm rocks, and rocks longer than 10 centimeters.
8. Fill in the data table recording the number of clasts in each size category for each formation. Then use the scale to record the mass in grams.
9. Each student will make a 3-D sketch and color several of the larger clasts from each group on the sheet provided. If you have a student who is a good artist you may want to ask him or her to show the class on the board how to do it. They will also write a descriptive sentence or two describing each group of clasts. You can suggest that they describe it to some one who is from the planet Mars.
10. Quantify the data. Using the completed data table, each student will construct two histograms showing the masses of clast size distribution and type in each formation. Color the histograms. Some students may never have constructed a histogram and will benefit from an explanation using the example in their instruction sheet.

DIFFERENTIATION:

Students of all abilities will be able to participate in collecting and sorting the clasts. Students with math accommodations can fill in the data table without calculating the percentages. All students can sketch and write descriptions, although the work of students with accommodations may not be as sophisticated.

For the histograms, some students can plot just the numbers, instead of the percentages. Students with accommodations may need the analysis questions read to them and prompts to help them think through the last question.

CONCLUSIONS: Students draw conclusions from their data table and histograms.

Which formation had more rounded clasts?

Which formation had more angular clasts?

What was the difference in the number of large clasts in the two formations?

How can you explain the differences in the clasts of the two formations?

ASSESSMENT:

- Active participation in gathering the buckets of materials and in sieving them.
- Completed histograms
- Sketches with descriptions
- Support their conclusions with their data

EXTENSIONS:

All groups report their data and record it on the Class Average Data Table constructed on the board. Have each student calculate the class averages, and construct a histogram. How does the class average compare with the results of their group?

REFERENCES:

1. What is what? Everything you always wanted to know.
<<http://en.mimi.hu/gis/clast.html>> December 29, 2006.
2. Shroba, Ralph, Thompson, R., Minor, S.A., Grauch, V.J.S., and Brandt, T.R. Lithologic Characteristics and Age Relationships of the Ancha Formation Depicted on the Geologic Map of the Agua Fria Quadrangle, Santa Fe County, New Mexico. US Geological Survey, MS 980, PO Box 25046, Denver Federal Center, Denver, CO 80225-0046.
3. Koning, D.J., Redefinition of the Ancha Formation and Pliocene-Pleistocene deposition in the Santa Fe embayment, north-central NM. New Mexico Geology. August 2002, volume 24, Number 3, p. 75-86.
4. Shroba, Ralph, Thompson, Rena., and Brandt, Theodore R., US Geol Survey, PO Box 25046, MS 980, Denver Federal Center, Denver CO 80225.
5. Love, David. New Mexico Bureau of Geology and Mineral Resources. New Mexico Tech University. 801 Leroy Place, Socorro, NM.

SIEVING FOR CLAST SIZE – Student instructions

OVERVIEW AND OBJECTIVES: You will take samples from two different geological layers and sieve for clast size counts and mass. You will also make sketches of some of the clasts and describe the rounded versus angular aspects in each of the formations. You can then prepare a histogram showing the percentages of clast size distribution by mass in each formation. Finally, you will draw conclusions on what forces of nature you think shaped the clasts and support your conclusions with your data.

MATERIALS:

For each group of three or four (you will also need scales for measuring mass):

Shovel or hand trowel

Ruler with metric scale

Hammer (maybe)

Colored pencils

Two buckets, labeled ‘Ancha’ and ‘Tesuque’

Graph paper

2 or 3 different sizes of sieves

Helpful information:

Clast - Pertaining to a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported some distance from their places of origin. (2) An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering (disintegration) of a larger rock mass.

In this activity, you will collect raw data for interpretation, much as geologists actually do in the field. The activity takes you through the stages of scientific inquiry: collecting data, interpreting the data and drawing conclusions.

In the Arroyo Chamiso on the grounds of Santa Fe High School, the Ancha and Tesuque Formations are exposed. These are both part of the Santa Fe Group, with the Ancha overlying the older Tesuque. The Tesuque Formation is composed of conglomerates, sandstones, and mudstones with locally preserved pumice beds. It was deposited as ancient streambeds and channels, floodplains, alluvial fans and windblown deposits. The Tesuque beds are primarily reddish sandstones tilted 14 degrees down to the west.

The Ancha formation was deposited by streams draining the Sangre de Cristo Mountains of previous times and is composed of silty sands and gravels ranging from pebbles to large boulders. The Ancha also contains layers of tephra from the explosions of the Cerros del Rio and Jemez volcanic fields. The Ancha Formation is 1.25 to nearly 3 million years old and is as much as ten times as permeable as the more consolidated and cemented Tesuque Formation. Common colors of the Ancha range from brownish yellow, yellowish brown and light yellowish brown to very pale brown.

Much of the city of Santa Fe is built on the Ancha Formation, while the Tesuque Formation is usually only visible in arroyos or railroad cuts. The Ancha Formation will be easier to collect first as it is not as cemented.

PROCEDURE:

1. Label your buckets “Ancha” and “Tesuque” and collect all of your materials.
2. Walk to the Arroyo with your teacher and have her point out the Ancha and Tesuque formations.
3. Using the bucket labeled “Ancha”, collect half a bucket of the Ancha Formation.
4. When everyone is finished collecting the first formation, move to the second formation and collect a half a bucket of the Tesuque Formation in the bucket labeled “Tesuque”.
5. Return to an outdoor location near your classroom where the sieving can take place. If necessary, use the hammer inside the bucket to break apart gravels that are embedded in loose sandstones.
6. Use the smaller sieve to allow the sand to fall through. This sand can be discarded. Use the larger sieve to separate pebbles from gravels and larger rocks.
7. Separate the gravels from the larger rocks by hand sorting. The larger rocks can be sorted into groups of 5-10 cm rocks, and then rocks longer than 10 cm.
8. Fill in the data table recording the number of clasts in each size category for each formation.
9. Make a sketch and color several 5-10 cm-sized clasts from the Ancha Formation and then the Tesuque Formation on the sheet provided.
10. Write a descriptive sentence or two describing each group of clasts.
11. Quantify the data. Using your completed data table, construct a histogram showing the masses of the clast size distribution and type in each formation. Color the histogram.

ANALYSIS AND CONCLUSIONS: (answer on the student worksheet)

1. Which formation had more mass of the rounded clasts?
2. Which formation had more mass of the angular clasts?
3. What was the difference in the total mass of the large clasts (>10 cm) in the two formations?
4. Why are some of the clasts rounded? Why are some of them angular? What is your explanation of what made them that shape?

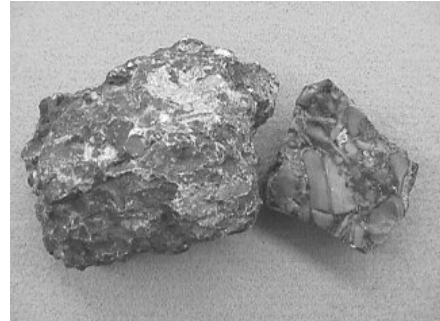
SIEVING FOR CLAST SIZE – Student Worksheets

DATA TABLE

- Fill in the data tables. Record the number of rounded and angular clasts in each size and category for each Formation.



Rounded Clasts



Angular Clasts

ANCHA FORMATION

Clast size	Rounded		Angular	
	Number	Mass (gm)	Number	Mass (gm)
<2cm pebbles				
2-5cm gravel				
5-10cm clast				
>10cm clast				
Totals				

TOTAL MASS OF ALL CLASTS IN ANCHA FORMATION: _____ gm

TESUQUE FORMATION

Clast size	Rounded		Angular	
	Number	Mass (gm)	Number	Mass (gm)
<2cm pebbles				
2-5cm gravel				
5-10cm clast				
>10cm clast				
Totals				

TOTAL MASS OF ALL CLASTS IN TESUQUE FORMATION: _____ gm

2. Make a three-dimensional sketch of two of the larger clasts from the Ancha Formation. Color them. Do the same for the Tesuque Formation.
3. Write a descriptive sentence or two describing each group of clasts. Use complete sentences!

ANCHA FORMATION CLAST SKETCHES	

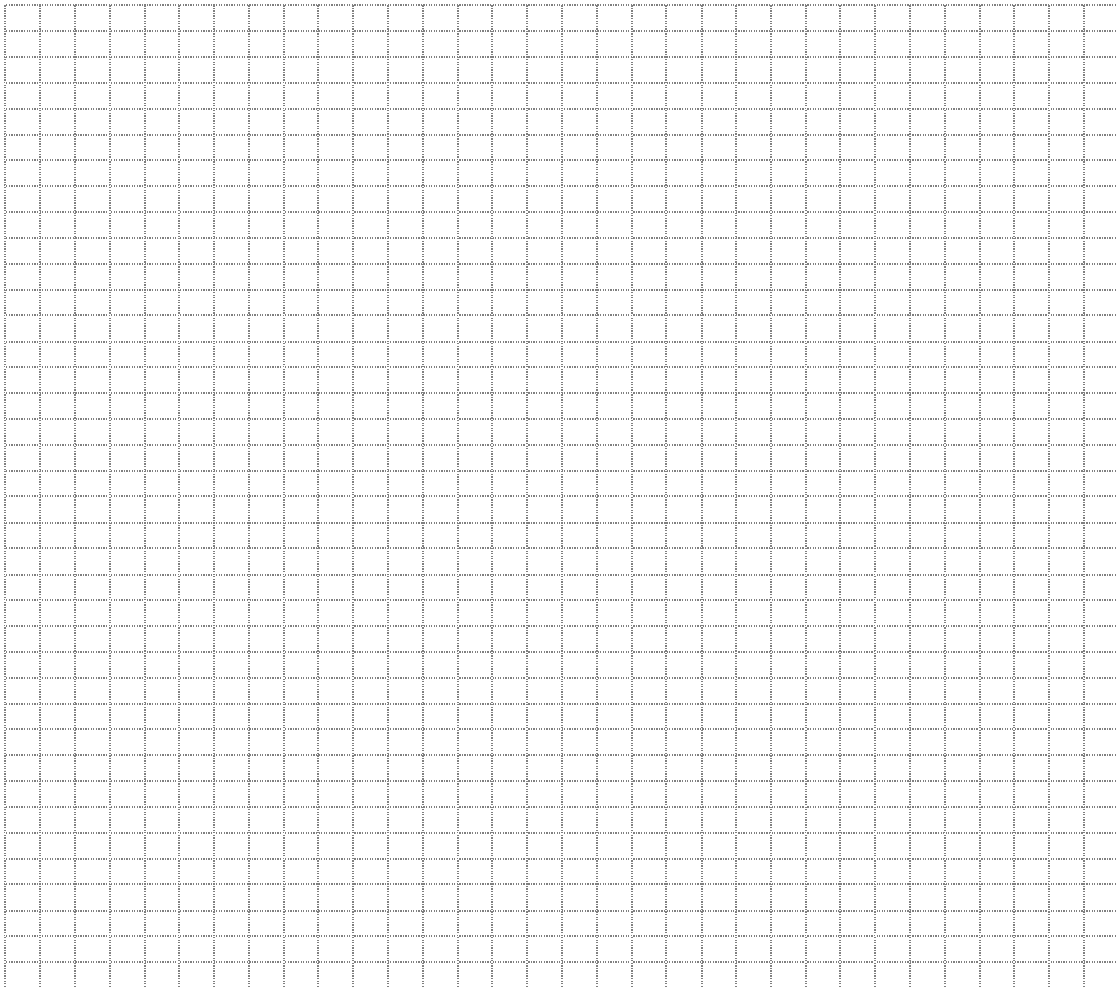
Description of Ancha Formation clasts: _____

TESUQUE FORMATION CLAST SKETCHES	

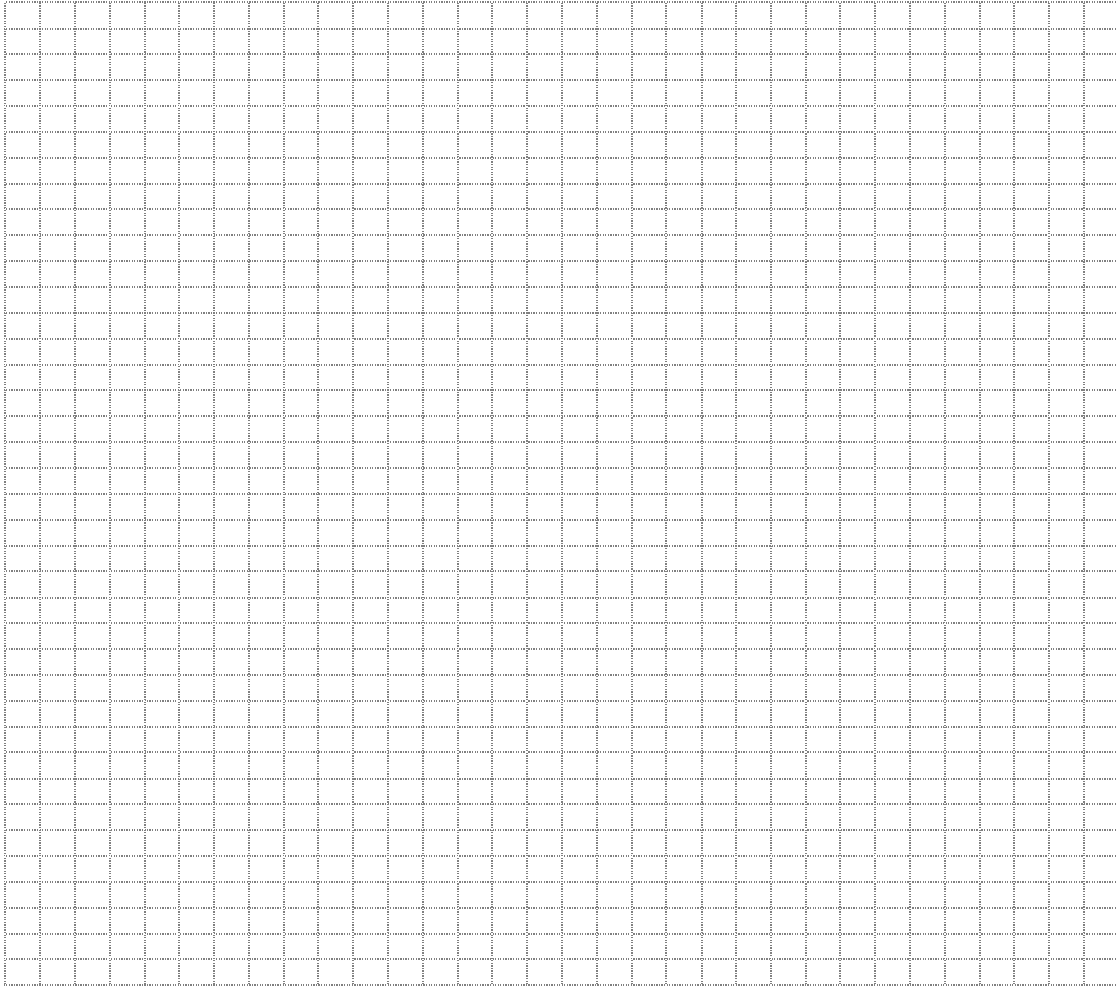
Description of Tesuque Formation clasts: _____

4. Quantify the data. Using your completed data table, construct two histograms. The first histogram will show the MASS of **rounded** clasts found in each size category in the Ancha and the Tesuque Formation. The second histogram will show the MASS of **angular** clasts found in each size category for each Formation. You will need to label each of your axes before plotting your data. Color the histograms.

**HISTOGRAM 1:
COMPARING THE MASS OF ROUNDED CLASTS IN THE ANCHA
AND TESUQUE FORMATIONS OF SANTA FE BY CLAST SIZE**



HISTOGRAM 2: COMPARING THE MASS OF ANGULAR CLASTS IN THE ANCHA AND TESUQUE FORMATIONS BY CLAST SIZE



ANALYSIS AND CONCLUSIONS:

5. Which formation had more mass of the rounded clasts?
6. Which formation had more mass of the angular clasts?
7. What was the difference in the total mass of the large clasts (>10 cm) in the two formations?
8. Why are some of the clasts rounded? Why are some of them angular? What is your explanation of what made them that shape?