Aggregates
Teacher Guide

Introduction

Crushed stone, sand and gravel are the three kinds of rock fragments that are called aggregates. Aggregates are the most mined materials in the world. Sand and gravel can be mined from sediments deposited by moving water, glaciers, and even from the sea floor. Crushed stone is produced from hard rock deposits.

We depend upon things constructed using aggregates every day in hundreds of ways. We drive on roads made from aggregates, take off from airport runways, and enter buildings that have foundations made from aggregates.

This Guide will help you get the most out of MEC free online resource materials about aggregates, MEC low-cost supplemental materials on aggregates, and other available aggregate teaching resources. It includes extension ideas that were suggested by teachers.

Free Online Resources

MEC Online Resources at www.MineralsEducationCoalition.org
The MEC website is your portal to K-12 information about minerals and mining. For aggregates, the MEC Minerals Database includes information on cement, crushed stone, dimension stone, limestone, quartzite, sand and gravel, sandstone, shale, granite and basalt. The Mineral Usage Statistics page includes the Mineral Baby, Per Capita Use of Minerals and USGS Commodity Summaries. Other pages have Aggregate Mine Reclamation Stories, photos from the Parkdale Quarry in Colorado and an SME Aggregates Briefing Paper.

Other Online Resources

- American Geosciences Institute
  - Earth Science Week
    - Toolkit
  - Aggregate and the Environment manual
- BeyondRoads.com
  - Students
  - Teachers
  - Asphalt Plant Tour
- California Construction and Industrial Materials Association
  - Products
  - Publications
  - Recycling
- Indiana Mineral Aggregates Association
  - Community Education
- National Asphalt Pavement Association
  - Consumer Center
- National Ready Mixed Concrete Association
  - Ready Mixed Concrete
- National Stone, Sand & Gravel Association
  - Rocks Build America
- Portland Cement Association
  - Cement and Concrete Basics
  - Concrete in the Classroom (Grades 7-12)
- Smithsonian National Museum of Natural History
  - The Dynamic Earth

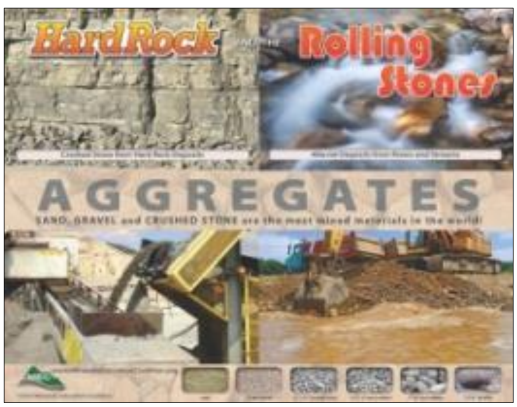
    Choose “Multimedia Version” or “Printable Version,” and explore “Rocks and Mining.”
- State Aggregate Associations list
- State Asphalt Pavement Associations
- United States Geological Survey (USGS)
  - Aggregates
  - Fact Sheet

Supplemental Materials

MEC Supplemental Materials

“Aggregates” Poster

MEC’s poster, “Hard Rock and the Rolling Stones: Aggregates,” shows aggregate samples and some of the environments and rock formations from which they originate and are mined. The back of the poster has aggregates-focused activities that teachers may photocopy and use in their classrooms, with such topics as learning about aggregates in the rock cycle, understanding the value of mining and producing aggregates near where the aggregates will be used, and examining deposits of aggregates along local rivers and streams. The poster is available from the MEC store at www.MineralsEducationCoalition.org/store. The poster is also in the American Geoscience Institute (AGI) Earth Science Week Toolkit available to teachers starting October 2014 (Earth Science Week is October 12-18, 2014). View a short instructional video at http://www.earthsciweek.org/eswdenver to get the most out of MEC’s online resources.



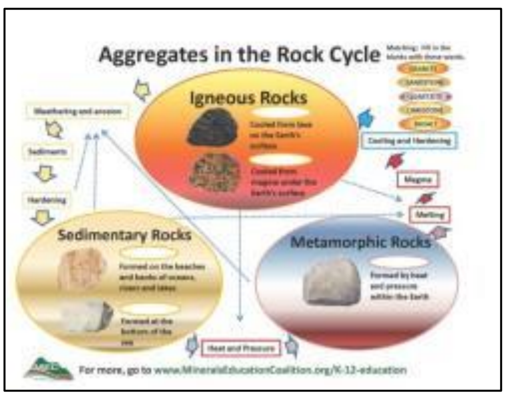
Find additional information about the activities on the back page of the poster, including answer keys and extension activity ideas from other teachers, below.

Upper Left Back Page--“Learn About Aggregates”

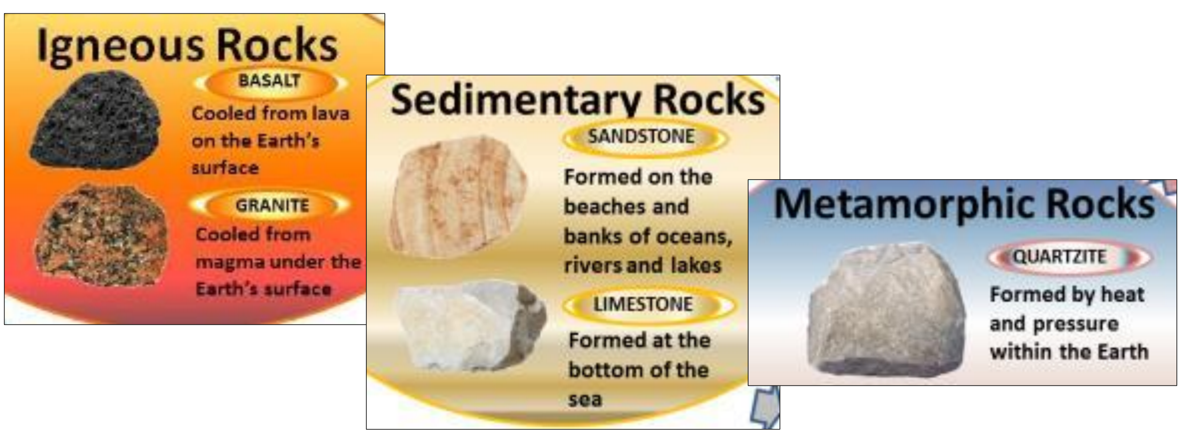
Extension ideas:

- Facebook template options for teachers:
    - http://www.teacherstechworkshop.com/2013/08/6-amazing-facebook-templates-to-use.html
    - http://www.teacherspayteachers.com/Product/Facebook-Template-Handout-260839
    - http://bestteacherblog.com/printable-facebook-pinterest-082913/
    - http://mrsmcclass.blogspot.com/2012/08/facebook-templates-for-education.html
    - http://missmosbacker.wordpress.com/2012/06/16/facebook-template-for-teachers/
- Create a video/slide show with aggregates-related songs like "Rolling on the River," "We Built this City," etc. Add pictures of aggregates and labels or names, processes involved, mining pictures, etc.
- Crushed stone quarries and sand and gravel pits are located close to every city in the United States. Contact your state aggregate association for an aggregate operation near you and invite a representative into your class or ask for a field trip to the operation.

Upper Right Back Page--"Aggregates in the Rock Cycle"



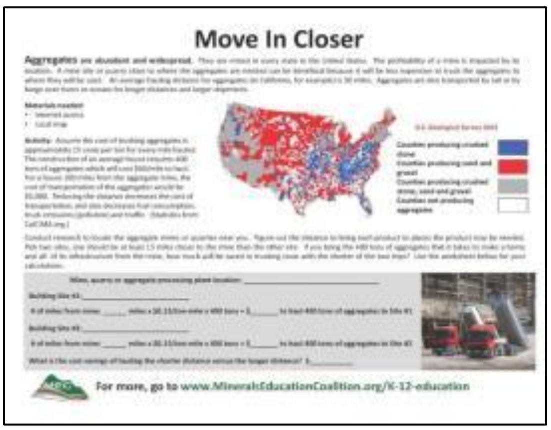
Answer keys:



Extension ideas:

- Create a game or interactive drag-and-drop SMART page from the above matching items.
- Have upper grade students research the process of metamorphism. Have the students look into different types of metamorphism, the temperatures at which it occurs, and the role that hot fluids have in the process. Good sites to consult include:
    - http://geology.about.com/cs/basics_roxmin/a/aa011804c.htm
    - http://www.physicalgeography.net/fundamentals/10g.html
    - http://csmres.jmu.edu/geollab/Fichter/MetaRx/index.html

Lower Left Back Page--"Move In Closer"



Answer example:

Mine, quarry or aggregate processing plant location: Local Stone Company and Quarry

Building Site #1: Home Developers Co.

# of miles from mine: 82.8 miles x $0.15/ton-mile x 400 tons = $ 4,968 to haul 400 tons of aggregates to Site #1

Building Site #2: House Builders Inc.

# of miles from mine: 30.5 miles x $0.15/ton-mile x 400 tons = $ 1,830 to haul 400 tons of aggregates to Site #2

What is the cost savings of hauling the shorter distance versus the longer distance? $ 3,138

4,968 Building Site #1
– 1,830 Building Site #2
Savings

Extension ideas:

- In addition to completing the "Move In Closer" activity to determine the cost to deliver aggregates from a local mine to local construction sites, also determine the cost to deliver aggregates from the local mine to your house or school. For a map of local aggregate mines, go to http://nationalmap.gov/ and make a map of local crushed stone and local sand and gravel operations (note: this site has taken over previous functions of www.nationalatlas.gov).

- Have students examine local roads, bridges and sidewalks for wear and tear. Can you see the various sizes and types of aggregates that have been used in the construction where there are cracks or wear?
- Have students observe the work being done at a local construction site (from a safe distance, of course). What aggregates are being used at the construction site? Why are they being used? What properties of these aggregates are important to this use, e.g., strength, durability, insolubility, porosity, particle size and shape? What types of machines are being used? Research the function of those machines. Here is the picture of a concrete pump, for example. Have you seen one of these?

<u>Lower Right Back Page--"Bank Deposits"</u>

Bank Deposits

For more, go to www.MineralsEducationCoalition.org/K-12-education

Extension ideas:

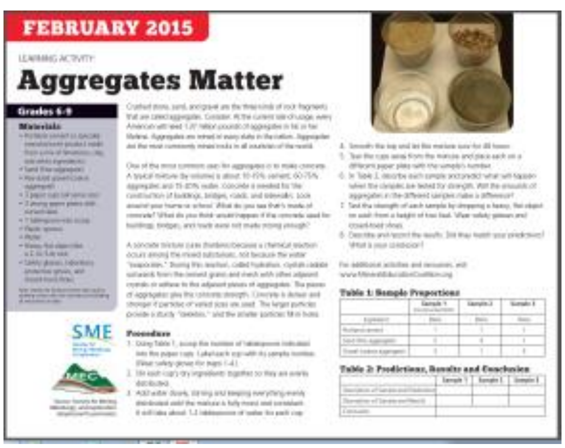
- Separate aggregates into different size categories. Give students a mixture composed of three to four different sizes of sand and gravel. Have students sort the aggregates by size and then identify how each is produced and used. Acquire samples from local hardware stores, nurseries, aggregate companies or ready-mix concrete companies. Consider going online and purchasing a set of sieves with gradually increasing screen sizes to use.
- You don't have to go to an actual streambed to see aggregates sorted by water. Go out after a rain storm and look where water has flowed. Can you see different sizes of gravel and sand sorted in different paths? How much rain did you get in the storm? What was the largest sized material moved by the rain storm? Can you tell which size was deposited first as the flow of the water slowed? Last? Why?
- Make or obtain a stream table and sort different sizes of aggregates with water of varying amounts and speeds.
    - To make a stream table:
        - http://vimeo.com/73380956
        - http://www.sciencefriday.com/blogs/12/20/2010/stream-table.html

- In addition to the links in the poster (below), here is a great place to find geologic maps of states--websites of state geological surveys, which can be easily accessed through www.stategeologists.org.
- Here are the links to resources mentioned in this activity on the poster:
  Geological map of your state:
  - USGS Mineral Resources Data mrdata.USGS.gov/geology/state
    - Geology.com Geology.com/state-map/
    - About.com geology.About.com/od/stategeologicmaps/

  Rock identification key:
  - Rockhounds.com www.Rockhounds.com/rockshop/rockkey/
  - Mining Matters www.pdac.ca/mining-matters/school-programs/students/rock-and-mineral-identification-guides/rock-identification-guide

Other Supplemental Materials:

“Aggregates Matter” Calendar Activity
Concrete is the most widely used manufactured material in the world. It consists of about 80% aggregates and 20% cement. Cement is the “glue” that holds concrete together. The MEC contributed the activity for the February calendar page for the American Geoscience Institute (AGI) Earth Science Week Toolkit available to teachers in October 2014 (Earth Science Week is October 12-18, 2014). In the “Aggregates Matter” activity, students can get messy to learn about aggregates. They can make three different concrete samples, with differing amounts of fine and coarse aggregate, and then test and observe how each sample stands up to an impact by dropping a rock on their concrete sample. It’s a fun way for students to start to get a feel for the 1.37 million pounds of aggregates they will likely use in their lifetime.


FEBRUARY 2015
LEARNING ACTIVITY
Aggregates Matter
Grades 6-9
Materials
Procedure
Table 1: Sample Proportions
Table 2: Predictions, Results and Conclusions

Extension Activities:

Introductory ideas:

- Look into how your state science standards tie into this topic. Many are listed here: http://www.educationworld.com/standards/state/toc/.

- Add essential questions and student objectives to the activity.
- Determine the target goal(s) from the new *Next Generation Science Standards* in an "I can" statement(s) for this activity.
- Create a problem for the students to solve. For example, "The school parking lot is in really bad shape. I know the ingredients that make concrete but I am not sure of the exact recipe. It is your job to help me make the repairs to the school parking lot." This would encourage higher order thinking and give the student a real-world application for the use of aggregates. Or, include the creation of a true hypothesis, such as "If I add two parts Portland Cement to one part sand and one part gravel, will the concrete be strong enough to patch our school parking lot?"
- At the beginning of the activity, brainstorm situations where concrete is used. Is there a cost difference for each of the three mixtures? Will the strongest mixture always be the best choice? What properties of a concrete mix would be most valuable in an earthquake prone area? Prior to the activity, have some scenarios that encourage the students to think about the real world uses of concrete.
- For review, provide some comprehension questions of the reading material in conjunction with *Common Core Standards*.

Concrete recipe variations:
- Add a sample of cement with no aggregate as a control to the experiment.
- Have students try their own combinations of cement, water, and aggregate before suggesting the specific recipes in the lesson. The students could base it on a total of six parts, or even let them determine that themselves. Which combinations worked the best for making concrete? Why? Instead of giving the proportions, have the students experiment and use their math skills to create their own proportions. You may choose to give them the formula for concrete by the ounces or pounds of aggregate and have them reduce the amount to fill the cup that is included in the lesson.
- Try testing different amounts of time for curing the concrete. Does a much longer cure-time make a difference? Use the same recipe but allow different lengths of time for curing, then take a picture of your "smashing" test results.
- In the actual aggregates industry, different sand, gravel and cement mixtures are not necessarily good or bad. You could consider the three recipes in the activity as 1: "Typical (standard) mixture," 2. "finishing mixture" and 3. "concrete slab mixture" and, therefore, each mixture is good for a given purpose. One formula does not fit all uses. Do some research about different mix ratios. Contact concrete makers and users and find out what blend works for a particular purpose and why. Contact the Portland Cement Association or the National Ready Mixed Concrete Association, for example. Invite local professionals from the construction and concrete industry to discuss and demonstrate their work with your students.

Final product:

- Since the differently sized aggregates may affect the strength of the final concrete, have students examine and describe their final product. Have them inspect for air bubbles or other imperfections that could weaken the concrete.
- Before "smash testing" the samples to estimate strength, ask students to calculate the density of each sample. Determine the mass of each dry sample. Then use water displacement to calculate the volume, and let the samples dry again before testing for strength.
- Ask students to explain the difference between concrete and cement. It is important to distinguish between the terms as they are not the same thing, despite common usage to that effect. Cement is an ingredient in concrete.
- Have students research the history of cement (at least back to Roman times) and how modern cement plans manufacture cement. Why and how does it work? How does this manufactured cement compare with the natural "cement" that the Romans used? How is modern concrete similar to and different from concrete that the Romans made?

Conclusion

Aggregates are a great topic for student exploration. Come back to our website soon for even more information and ideas for teaching about aggregates.