

# Introductory Geoscience Students' Understanding of Rock Types

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# Conclusion

- The three rock types (igneous, sedimentary, and metamorphic) are meaningful and useful to experts, but not to students (novices)



# Categories

- Categories are used by people to simplify cognitive tasks
- Characteristics of categories can be applied to the entities within that category
  - Example: mammals



[www.whale-images.com/killer\\_whale\\_facts.jsp](http://www.whale-images.com/killer_whale_facts.jsp)

# Rock Categories

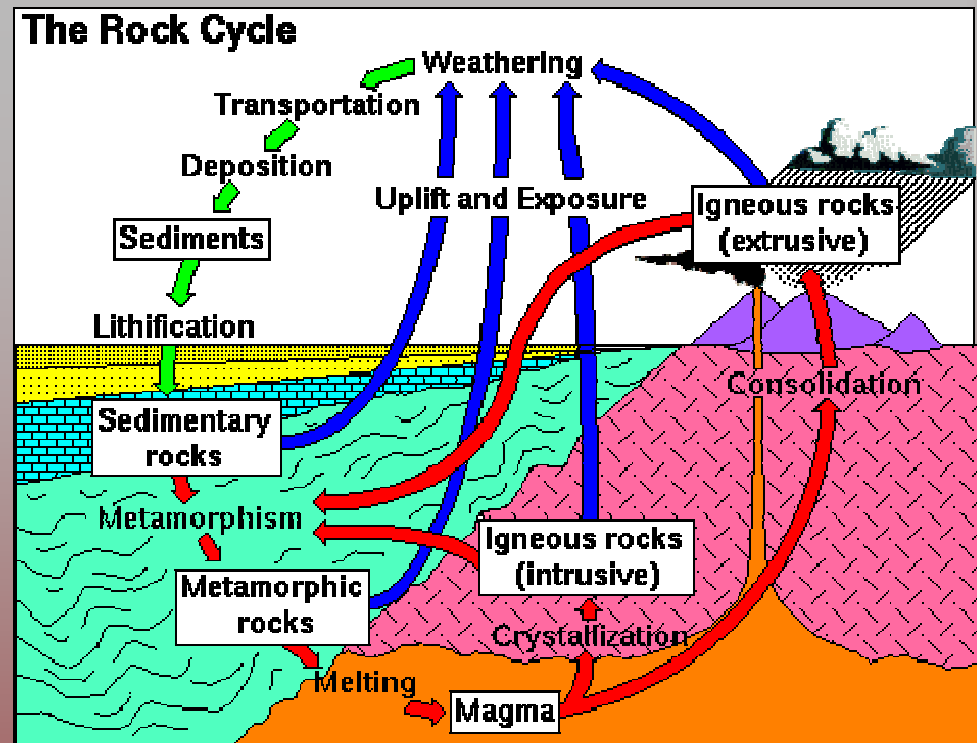


# Rock Categories

- There are many ways to divide rocks into categories
  - Color
  - Grain size
  - Location
  - Uses
  - Prettiness
  - Etc.

# Rock Categories

- Geologists organize rock into 3 categories
  - Igneous, sedimentary, metamorphic
- Categories are based on the way the rock formed





# Rock Categories and Experts

- Experts use the characteristics of the category to infer information about the rocks within
- Category tells a lot about rock
  - History, formation, conditions, plate tectonic setting, environmental setting, etc.
- Rock categories trigger prior knowledge

# Expert Example: Gneiss

- Metamorphic rock
- Therefore...
  - Formed at high pressures and temperatures
  - Deep within Earth
  - Uplift and erosion brought it to the surface
  - Likely a convergent boundary





# Expert Summary

- The three rock categories are **meaningful** and **useful** to experts
- Experts infer rock characteristics and processes involved from the category

What do the three rock types mean  
to students (novices)?

# Methods

- Methodological approach – qualitative
- Research tool – semi-structured interviews
- Research population – 10 students in 3 introductory geoscience courses at a community college
- Analysis – thematic content analysis
- Building trustworthiness – e.g. triangulation, agreement between coders

# Analysis

- Examined students' comments when they said "igneous," "sedimentary," or "metamorphic"
- Categorized how they said they identified the rock
- Categorized how they said the rock formed

# Results – Igneous

- How to identify
  - Black
  - Air bubbles
- How it formed
  - Magma hardens by cooling, drying, or chemical reactions with air
  - Sediments, rocks, or minerals added to magma
  - Sediments (may come from magma) compact together (may be done by magma)



# Student Quote

- Interviewer: Why don't you think it's igneous?
- Student: When I think of igneous, I think of like darker, an all dark rock. ... Lava that just got harder, and it's like all black. ... When I see something with different minerals in the different colors, and the different sizes within the rock, I don't think that it would be igneous. I think it ... would be sedimentary.





# Results – Sedimentary

- How to identify
  - Layered
  - Contains fossils
  - Contains pieces (that are not shiny)
- How it formed
  - Sediments come together (deposited, stick together, connect to rock)
  - Sediments form a rock by drying, compacting, heating



# Student Quotes

- “It looks like, because of the layering that it’s a sedimentary rock.”
- “It almost seems sedimentary .... It just seems there’s so many different parts to it, so many different colors.”



# Results – Metamorphic

- How to identify
  - Shiny
  - Flakes or crystals
  - Many colors or dark color
- How it formed
  - Rock changes by chemical reactions, minerals growing, crystallizing
  - Rock changes because weathering, fossils imprint, melt, pressure, heat



# Student Quote

- Student: It's probably most likely metamorphic if it left the fossil marks.
- Interviewer: Can you explain that to me?
- Student: Metamorphic rocks change and this obviously didn't come like this. It was a rock and then the fossils made a change.





# Summary

- Sediments occur in any rock type
- Black rocks or black pieces in rocks were once molten
- Any change to rocks can be considered metamorphism



# Questionnaire

- Nearly 200 students filled out questionnaires about rocks
- Nearly 900 statements coded
- 12% of statements were incorrect because they discussed one rock type using descriptions more appropriate for another
- 34% of students made these incorrect statements



# Student Quote

- “Has quartz and hornblende, coarse grained or phaneretic sedimentary rock that is foliated and cools on the surface.”



# Conceptual Barriers

- Deep Time – the great length of geologic time
- Changing Earth – the Earth is constantly changing
- Large Spatial Scale – large scale at which things happen
- Bedrock – rocks form and exist as bedrock
- Materials – the properties of materials that make up rocks
- Atomic Scale – processes that happen at the atomic scale
- Pressure – the scale and cause of pressure

# Granite

- Common example of igneous rock used by geologists



# Granite to Experts

- Granite is igneous
- Therefore...
  - Was once magma
  - Cooled into rock slowly, deep beneath surface



# Student Quote

- “A lot of beaches, they have different color sand... You basically take... some of the black, some of the white, some of the mix that we have here, and you crush it together, you end up forming a new type of rock or a certain type of rock, like granite.”

# Student Quote

- Interviewer: Some people say that granite is an igneous rock.
- Student: I can see that. ... I believe an igneous rock is a black shiny rock. ... Yeah, it does have a black shiny rock in it, so it could be a form of an igneous rock because it has some of it in it.



# Granite to Students

- Not necessarily magma (Atomic scale)
- Black minerals perhaps originate from magma (Materials)
- Pre-existing pieces (Changing Earth)
- Forms as handsample (Bedrock, Large scale)
- Come together over the course of years (Geologic time)

# Conclusion

- Students do not understand how many common rocks form
- Students tend to use physical characteristics to classify rocks
- Students fail to identify the usefulness of the classification routinely employed by geologists

# A Final Student Quote

- “I know what I’m explaining is more of a metamorphic process, but for some reason I’m picturing metamorphic rocks as all dark rocks and this is not all dark, so therefore there is something not consistent with this being a metamorphic rock. I’m thinking it’s more of an igneous rock.”