

Four Regions, Five Resources: A Resource Detective Jigsaw

Learning target: I can work with a team to use clues about a region's rocks, climate and plate history to predict which natural resources it has, and explain each prediction with the process that forms the resource.

Collaborative investigation

About 50 min

Jigsaw

MS-ESS3-1 · practice

collaboration

discussion

writing

Name _____

Date _____

Period _____

Directions

Work in home groups of four. Step 1 (expert round, 12 minutes): each member takes one region's three cards (Region 1: cards 1-3; Region 2: cards 4-6; Region 3: cards 7-9; Region 4: cards 10-12), reads them, and meets with the students from other groups who hold the same region to agree on what the region has and why. Step 2 (home round, 18 minutes): return to your home group, teach your region in two minutes, and complete the group prediction table together. Step 3 (challenge, 8 minutes): trade tables with a neighboring group and challenge one prediction with evidence from the cards. Step 4 (individual, 12 minutes): answer Part C alone. The four regions are invented for this activity, but every clue is the kind geologists really use.

You will need: Twelve cards per group, cut from the card sheet, One prediction table per group, Pencils, Timer

Twelve evidence cards (four invented regions, three cards each)

1 Card 1: Cinder Range, the rocks

A chain of steep volcanoes, two of them active, runs through the region. Between the volcanoes, old granite is exposed, laced with quartz veins that carry green and blue copper stains. Soils on the slopes are thin and stony. Hot springs bubble up along a line of cracks in the rock.

2 Card 2: Cinder Range, climate and water

Rain and snow total about 1,200 mm a year. Streams run all year, fed by snowmelt. Shallow aquifers in the valley gravel refill every spring; a well drilled in 1995 shows the same water level today as when it was drilled. Water from one spring comes out at 96 °C.

3 Card 3: Cinder Range, plates and history

An oceanic plate sinks beneath the region today, 150 km to the west, and has done so for about 40 million years. Earthquakes are frequent. Magma sits 5 to 8 km below the volcanoes. The region has never been under the sea in the last 100 million years.

4 Card 4: Saltmarsh Flats, the rocks

Flat land underlain by thick layers of limestone and shale. The limestone is full of fossil clams and corals. Below 2 km, drillers pass through a dense shale that bends into a broad arch, then a porous sandstone, then a dark shale that smells of oil. No volcanic rock anywhere.

5 Card 5: Saltmarsh Flats, climate and water

Rain totals about 200 mm a year; it is a semi-desert. The only aquifer is 300 m down in old sandstone; its water, when tested, last fell as rain roughly 12,000 years ago. The water level in the region's wells has dropped 15 m in the last 30 years.

6 Card 6: Saltmarsh Flats, plates and history

The region sits in the middle of a plate, 1,500 km from the nearest boundary. About 150 million years ago it lay under a warm, shallow sea for tens of millions of years. Later it was buried under new sediment and gently folded. No volcano has erupted here in 300 million years.

7 Card 7: Riverbend Lowlands, the rocks

A wide valley floor of silt and clay dropped by a large river's floods, layer on layer. The dark topsoil is 1 to 2 m thick and rich in decayed plant matter. Below the silt is 50 m of sand and gravel, then hard, ancient bedrock with no fossils. No ore minerals have ever been found.

8 Card 8: Riverbend Lowlands, climate and water

Rain totals about 1,100 mm a year, spread through the year. The river floods most springs. Wells in the sand and gravel refill within weeks after pumping, and water levels have been steady for 60 years. Forests of fast-growing trees cover the hills on either side of the valley.

9 Card 9: Riverbend Lowlands, plates and history

The region is deep inside a continent, far from any plate boundary. The bedrock is about 2 billion years old and has been worn flat; it was once part of a mountain range that eroded away long before the valley formed. The region has not been under the sea for more than 400 million years.

10 Card 10: Old Shield Plateau, the rocks

A high, flat plateau of ancient granite and gneiss, worn smooth. No layered sedimentary rock, no fossils, no volcanic rock younger than a billion years. Soils are a few centimeters thick or absent. A few old quartz veins carry traces of copper, too thin to mine.

11 Card 11: Old Shield Plateau, climate and water

Rain totals about 150 mm a year. There are no permanent streams. The only aquifer is in cracks in the granite 200 m down; its water last fell as rain about 20,000 years ago, when the climate was wetter. The one town's wells have dropped 25 m in 40 years.

12 Card 12: Old Shield Plateau, plates and history

The region is in the stable interior of a plate; the last subduction zone here shut down more than a billion years ago, and the mountains it built eroded away. There has been no magma near the surface since then, and no sea for at least 500 million years.

Part A: Expert round (one region per person)

1. Your region: _____. From your three cards, list the clues that point *toward* a resource and the clues that point *against* one. Name at least two resources your region should have and one it should not, with the card number for each.

Part B: Home group task

1. Each expert teaches their region in two minutes: the rocks, the water, the plate history, and what resources the clues point to.
2. As a group, fill in the prediction table. In each cell write 'likely', 'unlikely' or 'small amounts', and the card number that is your best evidence.
3. For groundwater, do not just write likely or unlikely. Write two things, using the card evidence: is the water renewable (does nature refill it within about a human lifetime?), and is today's pumping sustainable (is it no faster than the refill?).
4. Below the table, write the one process that explains each 'likely'. For example, a 'likely' for copper must name magma from a subduction zone.
5. Prepare one challenge for the neighboring group's table: pick a cell you think they got wrong and the card that proves it.
6. Make sure every member can defend every cell. The challenge round can be aimed at anyone.

Group prediction table (fill in)

Region	Petroleum	Copper ore	Geothermal energy	Groundwater: renewable? Current use sustainable?	Fertile soil
Cinder Range					
Saltmarsh Flats					
Riverbend Lowlands					
Old Shield Plateau					

2. Group answer: Which region is richest in resources and which is poorest? For the poorest, explain using its plate history why it has so little, and name the one resource it does have and why that resource is in trouble.

3. Group answer: Record the challenge the neighboring group made to your table (which cell, which card) and how you answered it. If you changed a cell, say which one and why.

Part C: Individual accountability (complete alone)

4. Cinder Range and Saltmarsh Flats both have copper clues on their cards? Check again. Which one has copper, and which card and which process explain why the other does not?

5. Saltmarsh Flats and Old Shield Plateau both have deep, old groundwater that is dropping. Riverbend's groundwater is steady. Using the climate and rock cards, explain what makes the difference.

6. Choose one region and one resource it is likely to have. Write a short scientific explanation (claim, evidence from at least two cards, reasoning) for why that resource is there and not in a region that lacks it. Name the past or present Earth process in your reasoning.

7. A company wants to build a geothermal power plant in Riverbend Lowlands because it has plenty of water. Using the cards, write the two-sentence reply a geologist would give.

Resource-by-resource checklist

Use this checklist for every cell in the table. Petroleum: was the region under a sea long ago, and is there layered rock with fossils, a dark shale, a porous layer and a sealing layer? Copper ore: is there, or was there ever, magma from a subduction zone nearby, and are there copper-stained veins? Geothermal: is hot rock or magma close to the surface today (hot springs, active volcanoes)? Groundwater: how much rain falls, how fast do the wells refill, and how old is the water? Fertile soil: is there thick, dark topsoil built from fine sediment and decayed plants? If a region fails the first question for a resource, the answer is 'unlikely' no matter what else it has.

Region 5: write the cards

Invent a fifth region and write its three cards (rocks; climate and water; plates and history) so that it has exactly two of the five resources and is missing the other three, with every clue consistent with how those resources form. Trade cards with a partner and see whether they can predict your two resources from the clues alone. Then rewrite any clue that was too obvious or too vague, and explain in two sentences what made a clue 'fair.'