Unit Planner

North Vancouver School District
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Overview			
Subject:	Science	**Topic:**	Plate Tectonics
Unit Overview:	This unit engages students in an in-depth, student-directed investigation and several guided inquiries to discover, test, and use The Theory of Plate Tectonics. Plate tectonics is a relatively new, well-supported scientific theory that helps explain Earth's landforms, catastrophic events like earthquakes and volcanic eruptions, and other dynamic phenomena on and beneath Earth's surface. Throughout the lessons in this unit, students uncover many lines of evidence that support their understanding of present-day landforms. This evidence includes dramatic images of changes to Earth's surface resulting from earthquakes and volcanic eruptions; seismic data; GPS data, the fit of continents and distribution of fossils; information about Earth's crust and convection currents to understand Earth's inner structure; the age of rocks relative to seafloor spreading centers; and more. All of these data are pieces of the puzzle that students put together as they work like scientists to understand landforms in regions around the world and in BC.		
Grade:	8		
Unit Duration:	4 – 6 weeks	**Date:**	January 4 2017

Stage 1 – Desired Results

Big Ideas

Theory of Plate Tectonics is the unifying theory that explains Earth's geological processes

Core Competencies

Critical Thinking
- identify criteria that I can use to analyze evidence
- ask open-ended questions an gather information

Communication
- understand and share information about a topic
- present information clearly and in an organized way

Social Responsibility
- clarify problems, consider alternatives and evaluate strategies

Concepts	Unit Understandings	Transfer Goals	Essential Questions
• Convection • Density • Forces • Theories	**Students will understand that…** • the Earth's surface is constantly changing • earth's internal forces drive changes to the Earth's surface	**Students will be able to independently use their learning to…** • analyze data to see patterns, draw conclusions and make predictions • understand the impact of the Earth's movements on human interaction	**Students will keep considering…** • How do plate interactions help to determine risk to humans and the environment? • What causes the surface of the Earth to change? • How does what we see today unveil the Earth's past? • How can we predict and understand changes to the surface of the Earth?

First Peoples Principles

- Learning recognizes the role of indigenous knowledge
- Learning is embedded in memory, history and story
- Learning is holistic, reflexive, reflective, experiential and relational (focused on connectedness, on reciprocal relationships, and a sense of place).

Alignment Check:

Are your concepts, unit understandings, transfer goals, and essential questions connected and supportive of your Big Idea?

Curricular Competencies

Students will be skilled at…

Applying and Innovating
- Model the types of plate movements
- Interpret information from data

Questioning and Predicting
- Predict where mountain building, earthquakes, and volcanic activity are likely to occur

Processing and analyzing data and information
- Present evidence to support the arguments for the theory of plate motion
- Draw conclusions about the theory of plate tectonics based on historical data

Communicating
- Communicating perspective of place in relation to plate tectonics

Content

Students will know that…

- Plate tectonic movement
  - Types of plate boundaries
  - Plate boundaries
  - Earthquakes and volcanoes
  - Measurement of Earth's plate movements
  - Aboriginal knowledge of local geological formation
- Major geological events of local significance
- Layers in Earth
  - Crust, mantle, outer core, inner core
- Earthquakes and volcanoes occur near plate boundaries and can have catastrophic effects on living populations

Stage 2 – Evidence: Assessing for Understanding

Assess: Understanding

Summative: Culminating Performance Task(s) at the end of the unit to show understanding	**Formative:** Checkpoints for understanding during the unit
Teachers should consider how assessment should be differentiated to meet students' diverse needs, interests, and learning styles.	Teachers should consider how formative assessment is ongoing, varied, and central to the instructional learning cycle.

AUTHENTIC PERFORMANCE TASK: Assessing for Understanding

Students will be able to demonstrate their understanding by:

What is a **GRASPS** task?

G R A S P S	
Goal	Understand the impact plate tectonics has in our community
Role	Individual or group project • Geologist • Community planner • Presenter • Writer • Emergency response team • Engineer/architect

Audience	• Students would have choice as to who they are presenting to
	  ○ Students in their school or to a younger age group
	  ○ Community
	  ○ Parents
	  ○ School board
	  ○ Mayor and council

Situation	It has come to our attention that there needs to be seismic upgrades made to some of our schools in North Vancouver. You are the lead scientist for the district of North Vancouver who investigates earthquakes. Your Earthquake project has been accelerated by the Mayor of North Vancouver. He wants to know: • Where the most recent earthquakes are occurring and if they are more likely to occur in certain locations (analyzing data) • Whether or not there is any way to

OTHER EVIDENCE: Assessing for Knowledge and Skills

Students will show they have acquired Stage 1 knowledge and skills by:

Pre-assessment – use the class brainstorm to see what the students know about the topic already and what questions need to be answered. Do a class wonder wall – have students put up questions they have about the earth so that you can address the questions throughout the unit.

Some sample True/False Questions

1. Continents are smaller now than they were in the past.
2. The size of the earth is gradually increasing over time because of seafloor spreading.
3. Tectonic plates float on melted magma that is just below the surface of the earth.
4. The Earth's mantle is made up of molten rock.
5. The edge of a continent is a plate boundary.
6. The amount that a tectonic plate moves during a person's life is measurable.
7. Earthquakes are rare events.
8. Scientists cannot predict earthquakes.
9. Vancouver will not fall off into the ocean.
10. Earthquakes occur only on the Ring of Fire.
11. Volcanoes can form when a plate moves over a hot spot.
12. Magma comes from Earth's outer core.
13. An inactive volcano may erupt again some day.
14. Volcanic eruptions occur randomly.
15. All mountains can become volcanically active.
16. Rocks give us clues about the Earth's history.

Layers of the Earth
- Analogy to chocolate bar
  - Adaptation – students can just match the layers with layers of earth, no explanation needed or they can label a diagram that you provide for them
  - Extension – have students come up with their own analogy (NOT the chocolate bar)

	determine what parts of the world are most prone to them (questioning and predicting) • What is causing the earthquakes (content – layers of earth, plate tectonics, geological events) • What are the effects on peoples lives (impacts on society) • What should the emergency response plan look like (problem solving)
Performance or Product	Students can present their information to their audience in a variety of ways. You may want to give students the option to choose how they present their learning such as: • Powerpoint • Letter • Pamphlet • Video • Report • Poster
Standards	• An accurate explanation of how earthquakes develop • An accurate understanding of the processes under the Earth's crust • Interpreting information from data to support their arguments • The use of multiple representations (diagrams, tables, graphs, etc…) to support their understanding of the topic • The use of The Theory of Plate Tectonics to determine our risk level for earthquakes in the Lower Mainland • A clear and understandable explanation, suited to the audience
Differentiation:	Adaptations: • Have students work in heterogeneous/multileveled groups • Pick the students roles based that fit their strengths Extensions • The role of architect/engineer will be a more challenging role and require students to make more interconnections between concepts • Students can look into soil composition and how it will be affected during an earthquake • Students can look at the land that our schools are built on and if that is a good location due to soil

Convection
- Using the words mantle, crust, heat, less dense, movement, describe convection currents in the Earth

Tectonic Plate movements
- Odd One Out – use similar items and challenge students to choose which item in the group does not belong. Students are to justify their reason for selecting the item that does not fit with the others.

Theory of Plate Tectonics
- On Solid Ground – article on Wegner's development of his theory
  - Thinking Routines – Connect-Extend-Challenge. (page 132 in Making Thinking Visible)
  - Class brainstorm of the evidence for the movement of the plates from the article

Plate Tectonics and Earth's features
- Have student pick a certain geological feature or an Earth event (student choice) and explain how these are formed through their understanding of plate tectonics
  - Examples: volcanic eruptions, earthquakes, mountain ranges (BC coastal mountains, The Rockies, The Alps, etc.), Tsunamis, Geysers, etc…

Geological formations and Changes to Earth
- Chalk talk (page 78 in Making Thinking Visible)
- Circle of Viewpoints – perspective taking (page 171 in Making Thinking Visible)
- Sentence – phrase – word (page 207 in Making Thinking Visible)

Quizzes
- Quizzes can be used to check-in after acquisition lessons

Science Journals
- Use the science journals to see how they students are thinking but also to see what questions the students have

Lab Activities
- Use lab activities to asses students skill at making qualitative and quantitative observations
- Density lab – great opportunity to incorporate graphing skills and mathematical computations using formulas

Assess: Know & Do

Summative: Final assessments of knowledge and skill at the end of the unit	**Formative:** Checkpoints for students to show their knowledge and skills during the unit
Teachers should consider how summative assessments should be based on clear criteria and include a variety of ways for students to show demonstrate their learning	Teachers should consider how this ongoing assessment is clear, specific, and timely in order to support student progress
• Final test • GRAPS	• Quizzes • Chapter Questions • Vocabulary Activities

Stage 3 – Executing the Learning Plan

These learning events/activities are suggested activities. Some activities may span over several lessons. Teachers should add, revise, and adapt based on the needs of their students, their own personal preferences for resources, and a variety of instructional techniques.

Part 1: Layers of the Earth (A)

Hook: Layers of the earth song on youtube; https://www.youtube.com/watch?v=NAHY6965o08
KWL with the class using the guiding question: How many layers of the Earth are there? What are they?

- Students will know the layers and composition of the layers of the earth (A)
- Label a diagram of the Earth's layers (A)
- Describe the composition of the Earth's layers on the same diagram (A)
- Density (T & M)
    - Density level differs on the chemical make-up of the substance (extension – have students look up the different chemical make-up of the layers and possibly look up the density value of the substance. Adaptation – students can compare more dense and less dense between 2 objects)
    - talk about how the different chemical makeup of each layer allows the layers to occur and not mix
    - Inquiry – different substances with different densities and students are to layer them like the layers of the earth. Students should be able to use density to explain how it works
        - Adaptation – class demo that the teacher does with the substances to show that the layers do not mix

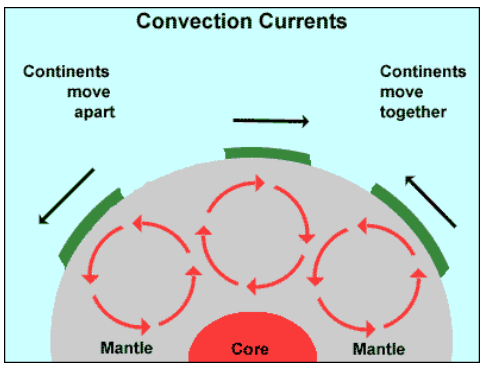
Science Journal: Analogy- show a picture of a chocolate bar and have students develop an analogy of how the layers are related to the layers of the earth (T). See an example below:

1. Place a Milky Way candy bar on a paper napkin.
2. Cut down the middle of the candy bar.
• The chocolate on the top of the candy bar represents the crust of the Earth. This is the thinnest layer. It is made up of soil and rocks. The land we walk on and the land under the oceans are part of the crust.
• The caramel layer represents the mantle. It is made up of hot molten rock. This molten rock is what erupts from volcanoes in the crust.
• Notice the light brown layer and tell them it represents the outer core. It is made up of liquid iron.
• The bottom layer of chocolate is the inner core of the Earth. This layer is made of solid iron and is the hottest part of the Earth. The temperature of the inner core is almost as hot as the sun.
3. Don't forget to eat the layers of the Earth!

Part 2: Convection Currents

What's happening in the Earth?
Hook: boil rice in water – Students will observe rice move in a circular motion. Students will make observations of what they are observing in their science journals (A & M)

- Discussion/notes on convection and how convection works (A)



- Convection demo with water and food colouring (A & M)
- Connect to the layers of the earth and how the layers are moving beneath the earth's surface (A & T)

Science Journal –
- Draw boundary between lithosphere and upper mantle and take notes on how and why convection currents occur and how the convection current affects the lithosphere
- How does temperature differences affect the movement of materials?
- Using the words mantle, crust, heat, less dense, movement, describe convection currents in the Earth

Part 3: Tectonic Plate Movements

How does movement within the earth cause changes at the surface?
Hook:
Corn syrup and continental drift – corn syrup and crackers on top. Heat syrup, becomes less dense and the "continents" start moving apart

- What does the syrup represent?
- What do the crackers represent?
- What is more dense? How do you know?
- Using the words mantle, crust, heat, less dense, movement, describe convection currents in the Earth

Activities

- Odd One Out – give students a set of key terms (3 words) and have them circle the Odd One Out and describe why it does not fit with the others (M)

- Plate Tectonic puzzle – evidence of the plates moving, create Pangea (A & M)
- Tectonic plates map – color and label the specific plates (A)
    - If possible have a blown up map of British Columbia and label the plates surrounding BC
- On Solid Ground – article on Wegner's development of his theory (M & T)
    - Thinking Routines – Connect-Extend-Challenge. Have students share out to class (page 132 in Making Thinking Visible)
    - Class brainstorm of the evidence for the movement of the plates from the article

Science Journal:
What four types of evidence were used to prove that a continent was once part of a larger continent? Adapted – just list; Extension – support with evidence
How did people historically think about Earth's surface?
How does Wegner's Theory of Plate Tectonics help us understand the changes to Earth's surface?

Part 4: Tectonic Plate Boundaries

What processes occur at the plate boundaries that could impact Earth's features?
Why do we think plates are moving?

Hook: What causes mountains to form, earthquakes to shake and volcanoes to erupt? Class discusion
- Explore – plate tectonic gizmo (explore learning.com)– use computer simulation to explore the various types of plate boundaries and their consequences students can begin to fill-in their own notes using the template below
- Notes on boundaries organizer (A)

Type of Boundary	Sketch of Boundary	Direction of movement	Description/features	Example
Diverging				
Transform				
Converging (collision)				
Collision (subduction)	Ocean-ocean			
	Ocean-continent			

- Inquiry – Model convergent, divergent and transform boundaries using oobleck, pieces of rigid foam insulation or foam core, tiles or pieces of hardboard. (A, M, & T)
- Go back to tectonic plate map and add data about the plate boundaries. Label each type of plate boundary (May want to have a blown up map of BC and surrounding areas to have a better understanding of place) (A & T)
- Myths or stories about how the local Earth's features were formed (M & T)

Science Journal:
graphic organizer – Venn diagram of the plate boundaries (M & T)

Part 5: Measurement of Earth's Plate Movements

Using GPS technology to measure Earth's movements (M)
http://oceanlink.island.net/SOLE/tectonics/WCDA.html

http://www.iris.edu/hq/files/programs/education_and_outreach/aotm/14/1.GPS_Background.pdf

Science Journal:
How do scientists use GPS to measure movements in Earth?

Part 6: Geological formations and Changes to the Earth

What do geological formations (mountains, trenches, volcanoes) tell us about how the Earth changes and will continue to change?

Hook: Show a video of earthquake or volcanic damage? Without sound, have students infer what it was about.

Inquiry: (M & T)
- Give students a copy of the world map and the USGS data for recent volcanic and earthquake activity (each group different color)
- Have the 2 groups come together and compare their maps
- Superimpose their maps on a map of the plate boundaries
- Discussion Questions:
    - Is there a relationship between volcanoes and earthquakes?
    - Is there a way to determine what parts of the world are prone to earthquakes and volcanoes? How do you know?
    - Look for pattern and relationships between plate boundaries and earthquake data

Reading activities: (M)
- Recent articles about earthquakes or volcanoes that have occurred and what kind of damage they have done.
    - Seven Factors that contribute to the destructiveness of an earthquake (Smithsonian.com) article
    - What If? Richter 15 article

- Myths or stories about the formation of Earth's features (local)
    - https://www.hakaimagazine.com/article-long/great-quake-and-great-drowning
    - Huu ay aht Earthquake (1700's in Nanaimo)
    - http://oceanlink.island.net/SOLE/LP/FN/FN.html
    -
- Famous Earthquake accounts (musical plates online)
    - How did earthquakes affect the personal lives of the people you read about?
    - How did earthquakes affect their communities as a whole?
    - Were there differences in the reactions of the writers from different time periods? What were they?

Some activities to do with the readings:
- Chalk talk
- Circle of Viewpoints – perspective taking
- Sentence – phrase - word

Resources:

Books
BC Science 10
What If? By Randall Munroe
Science Formative Assessment by Page Keeley
Making Thinking Visible by Ron Richhart

Websites
Density Lab: http://www.bcscta.ca/resources/hebden/labhebden8.htm

Layers of the Earth song https://www.youtube.com/watch?v=NAHY6965o08

Seven Factors that contribute to the destructiveness of an earthquake
http://www.smithsonianmag.com/ist/?next=/science-nature/seven-factors-that-contribute-to-the-destructiveness-of-an-earthquake-44395116/

The Tectonic Challenge http://oceanexplorer.noaa.gov/okeanos/explorations/10index/background/edu/media/tectonics.pdf
Plate tectonic gizmo https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=446

Local history
https://www.hakaimagazine.com/article-long/great-quake-and-great-drowning

http://oceanlink.island.net/SOLE/LP/FN/FN.html

Teacher: Unit Reflection

What aspects of the unit went well?

What did students struggle with?

What did you struggle with?

Potential Students Misunderstandings:

- Plates are metres thick
- Plates are melted rock
- Earth's plates are separated by empty gaps
- Rocks are always solid
- The layer beneath Earth's plates mostly consist of liquid rock material
- The layer beneath Earth's plates mostly consist of solid rock material
- Continents only move inches over hundreds of years, not feet or miles
- Continents and ocean basins move, but so slowly that they will barely have moved after hundreds of years
- Earth's plates move by floating on a layer of melted rock
- Earth's plates cannot bend
- Mountains form by the piling up of pieces of rock
- Continental plate material is only pushed upward when it pushes into continental plate material on another plate

When two plates move away from each other, loose rock material fills the empty gap that forms between them

What would you add/revise the next time you taught this unit?

Were there any unintended outcomes?

Were students engaged?