CURRICULUM DESIGNED

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By

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ABSTRACT

Students need to 'Do' a subject rather then just learn the material. To merely cover the material is to 'travel over' the information, educators should aim to uncover the material "to find the value in what is hidden" (Wiggins & McTighe, 1998, p.106). Designing curriculum for understanding using the Backward Design Process is one way to achieve this. The Backward Design Process involves determining what teachers want students to do (derived from Ontario Ministry of Education curriculum Expectations) and proceeds to the evidence (assessment and evaluation strategies) teachers will accept that students have accomplished this. Then the teachers develop the instructional strategies or activities that will enable students to understand, not just know the material. Making clear what teachers want students to understand is paramount.

Educators need a clear plan to explain to students what is expected, what is to be learned and how they will learn. In Ontario, educators are teaching new curricula as secondary education shifts from five to four years. Course profiles are being written to provide teachers with a framework from which to teach the new courses.

I was a member of the provincial writing team for the Grade 11 Physical Geography: Patterns, Processes, and Interactions course that completed the Overview and Unit 1. This project extends the work I started (in the Overview and Unit 1) by using the Backward Design Process to design Unit 2: Structure of the Earth (Shake, Rattle, and Roll). The Backward Design Process is promoted by the Ontario Ministry of Education although they do not give the writers formal training sessions in the process.

Having completed Unit 2 using the Backward Design Process I now have a better understanding of how to organize information and skills for understanding. Considering what is most important (determining the Enduring Understandings from the Expectations) and determining how they can be evaluated and assessed leads naturally into developing activities that address the Enduring Understandings, the important understandings, the things students retain after the details have been forgotten (Wiggins & McTighe, 1998, p.9). This sequencing of curriculum development leads to the development of student understanding rather than just knowing the material or skill. Educators develop curriculum based on what needs to be understood in the discipline instead of activities based on available resources.

The Backward Design Process is a simple and concise method to use for designing a lesson, unit of study or entire curriculum. The designer must clearly identify what is important and determine what evidence will be accepted to verify achievement. This requires the designer to probe to the core of the discipline to determine what is essential that the student understand. Then the assessment strategies and finally the instructional strategies can be developed. Teachers in all disciplines can use the Backward Design Process regardless of the grade level or available resources. This is a useful process for designing curricula.

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My work is dedicated to Doreen Mary Susanna Hume, my inspiration and greatest fan in life. Her love and dedication to me provided me with the tenacity and perseverance to pursue this endeavour.

I also want to thank my advisors, Dr. Carolyn Eyles (School of Geography and Geology) and Dr. Alice Schutz (Department of Education, Brock University), for their support and guidance in all aspects of my educational journey. They allowed me to express myself professionally and personally to meet my expectations, theirs, and that of the programme.

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INTRODUCTION

Developing curricula is a tedious and time-consuming endeavor yet is necessary is prepare students for the world as it is and what it could be/may be in the future. Traditionally, practitioners (e.g., teachers) would start with an activity that they felt and/or knew provided a valuable lesson imparting knowledge and/or developing a skill. They developed a lesson around the activity and prepared an evaluation tool (e.g., test, essay) to judge the student's level of understanding. The activities and evaluation instruments were as varied as the available resources (material and human).

Today in Ontario there is a government mandate to standardize the curricula, what is to be taught, how it will be taught, and the assessment and evaluation tools to be used. This has been ill received by many teachers, afraid that creativity and ingenuity would be lost to standardization. In an attempt to understand the change in approach I volunteered to be a member of the team writing the course profile for the Grade 11 Physical Geography: Patterns, Processes, and Interactions (CGF 3M University/College) course. Our team of three used the Expectations of the course (generated by the Ontario Ministry of Education) to develop the Overview and overall framework for the course, determining the number of units (5) and content of each. We also developed Unit 1: Planetary Systems - Quest for Balance. To further my understanding of curriculum development and in particular the Backward Design Process I continued the work to include Unit 2: Structure of the Earth (Shake, Rattle, and Roll).

All course profiles developed by the Ontario Ministry of Education use the Backward Design Process (Wiggins & McTighe, 1998) to some degree. This is the method I used for designing unit 2. It provides a framework for developing curriculum, assessment, and instruction. It involves developing a curriculum for understanding. Curriculum for understanding refers to understanding that involves insights and abilities, demonstrated in varied performances and contexts (Wiggins & McTighe, 1998, p. 5). In this project I use the Ministry of Education curriculum Expectations and the evaluation and/or assessment tool that will indicate the level of understanding of the desired learning(s) (Enduring Understandings). Enduring Understandings are the "big ideas", the important understandings, the things students retain after the details have been forgotten (Wiggins & McTighe, 1998, p. 9). Developing a curriculum for understanding begins with what teachers want students to do (Enduring Understandings) and proceeds to the evidence (assessment and evaluation) that we will accept that they understand it, not just know it. Then we turn to how they will learn it (teaching strategies and activities). Teachers must make it clear what we want students to understand. Performance (something that is valued in the world outside schools) is the key to assessing understanding. The Backward Design Process differs from other methods for developing curricula because the Enduring Understandings and assessment and evaluation tools are developed before the teaching strategies and activities are designed. Therefore the activities address the Enduring Understandings /Expectations and assessment and evaluation strategies.

This project is the application of the Backward Design Process to the development of a unit of study, Unit 2: Structure of the Earth (Shake , Rattle, and Roll) complimenting my teaching area, Geology. It also includes reflection on the process and the resulting recommendations for implementation.

In Chapter 1 I outline the purpose for developing curricula using the Backward Design Process and provide definitions for educational terms.

Chapter 2 entails an explanation to support the Backward Design Process and how it is used to develop curricula.

Chapter 3 is a description of the process to follow when developing a course or unit of study using the Backward Design Process.

Chapter 4 is the process I followed in designing the unit of study and also includes my reflections on the process and recommendations for improvement and implementation. Feedback on the design of the unit by the lead writer of the provincial writing team for the Grade 11 Physical geography course (who is also the Coordinator of Social and Canadian World Studies, Halton District School Board) is also included.

Chapter 5 includes a summary of my understanding of the Backward Design Process.

CHAPTER 1

DESIGNING CURRICULUM

Designing curricula (a specific plan with identified lessons in an appropriate form and sequence for directing teaching; Wiggins & McTighe, 1998, p .4) is a daunting yet exciting task. In Ontario the process involves taking the Expectations (the set of knowledge and skills that a student will learn including Overall and Specific Expectations) determined by the Ontario Ministry of Education (Ministry) and transposing them into a plan for implementation. The desired result is to have students leave the course with general and subject specific knowledge and skills.

In the past, lessons have been developed based on available resources (material and human) thus varying from region to region and even school to school. Therefore the learning, depth and breadth would vary by the same degree. The teacher's belief system (educational beliefs about teaching and learning) is a key factor affecting the development and implementation of curricula. J. Miller (1983) describes seven educational orientations: subject, behavioral, social, developmental, cognitive process, humanistic, and transpersonal. If the teacher's educational orientation is congruent with the aims of a Ministry guideline then chances for implementation improve. If the teacher's orientation conflicts with the Ministry guideline, implementation may be arduous (Leithwood, 1986, p.16).

The Ontario government now demands standardization to equalize learning for all students. The curriculum design model advanced by the Ministry is that developed by Grant Wiggins and Jay McTighe (1988), referred to as the Backward Design Process. Initially the Ministry developed an electronic Curriculum Unit Planner (March 2000) that teachers could access to develop course work based on the new curricula and using the premise of the Backward Design Process. Unfortunately it was complicated to use and in my school, of 80 teachers, no one has used it.

The Backward Design Process provides a framework for developing curriculum, assessment, and instruction. The curriculum is designed for understanding beginning with what we want students to do and proceeds to the evidence that we will accept that they understand it. Understanding involves the insights and abilities, reflected in varied performances and contexts (Wiggins & McTighe, 1998, p 5). Assessment means the act of determining the extent to which the curricular goals are and have been achieved. Assessment includes the deliberate use of many methods (formal and informal) to gather evidence to indicate the students are meeting the standard. A central premise is that understanding can be developed and evoked only through multiple methods of assessment (e.g., observations, dialogues, quizzes and tests, projects, self-assessments; Wiggins & McTighe, 1998, p. 4). Once assessment tasks have been determined, how the student will learn the material is determined. The key is to make it clear what we want students to understand and performance is the key to assessing understanding.

The project described here is an extension of the work completed by the provincial writing team (November 2000 – February 2001) for the Grade 11 Physical Geography: Patterns, Processes, and Interactions (CGF 3M College/University) course, of which I was a member. I choose this project because I wanted to continue to develop my understanding of the Backward Design Process in greater depth by developing a unit on my own. I chose to complete Unit 2: Structure of the Earth (Shake, Rattle, and Roll) to compliment my teaching area, Geology. The unit will be implemented in September 2001 therefore I will not be able to provide feedback based on the implementation of the unit. Although, I have included a process to attain feedback regarding the intent of the unit and if the unit reflects Wiggin's & McTighe's design principles, the Backward Design Process. The unit of study has been reviewed by the lead writer of the provincial writing team for the Grade 11 Physical Geography course, who is also the Coordinator of Social and Canadian World Studies for the Halton District School Board (Halton). The review of the unit by a writer of curriculum represents a performance assessment and exemplifies the application of the Backward Design Process.

CHAPTER 2

RATIONALE FOR DESIGNING CURRICULUM FOR UNDERSTANDING

The Backward Design process helps teachers develop curricula for understanding where understanding involves insights and abilities, demonstrated in varied performances and contexts (Wiggins & McTighe, 1998, p. 5). Conventionally teachers approached curriculum based on the resources available, favorite activities or how best to cover a topic. Using the Backward Design process "one starts with the desired goal or standards and then derives the curriculum from the evidence of learning (performances) called for by the standard and the teaching needed to equip students to perform" (Wiggins & McTighe, 1998, p. 8). Performance-based assessments require students to apply knowledge and skills in context, not merely completing a task on cue (Brualdi, 1998, p.1).

The process begins with the question: "What would we accept as evidence that students had attained the desired understandings and proficiencies?" (Wiggins & McTighe, 1998, p. 8) and then the teacher proceeds to plan the teaching and learning experiences. This method helps teachers to clarify goals for self and students, providing the basis for better student performance.

The stages in the Backward Design Process are as follows:

1. Identify the desired results
2. Determine acceptable evidence
3. Plan learning experiences and instruction

It is the particular sequencing of the steps in the model that distinguishes it from other curriculum development models. A model previously developed by teachers, administrators, and the Ontario Institute of Studies in Education Field Staff (1986) entails:

1. Generating goals and objectives;
2. Development of instructional strategies (moving students along a learning continuum);
3. Assessment instruments; and
4. Instructional Manuals.

This sequencing develops the assessment tools after the instructional strategies or activities have been determined. The Backward Design Process has the teacher identify the evidence (assessment and evaluation strategies) that will signify the student has achieved the Enduring Learning(s)/goal(s)/Expectation(s) and then develops the instructional strategy(ies). This method removes the bias of teacher preference for certain activities and preparation based on particular resources.

In the Backward Design Process "the final product is a unit framed in terms of essential questions, which point clearly and explicitly toward a big idea" (Wiggins & McTighe, 1998, p. 19). We signal what the big idea is and it is the student's job to inquire into meaning, value, and confirmation of the important idea. "The big idea at the heart of the unit is not likely to be understood if it is merely taught. To be fully understood it will have to be explored, questioned, played with, used in realistic contexts, rephrased, and verified as important in some way" (Wiggins & McTighe, 1998, p. 114).

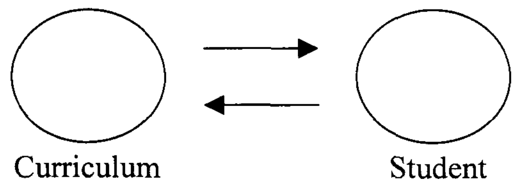
In the process the students have the opportunity to develop more sophisticated thinking through inquiries and performance tasks.

"Teaching for understanding aims at having students explain, interpret, and apply while showing insight from perspective, empathy, and self-knowledge" (Wiggins & McTighe, 1998, p. 64). This approach corresponds to Miller and Sellers (1985) orientations to education, transaction and transformation. The transaction orientation (Figure 1a) develops curricula for the development of intelligence and complex problem-solving (Leithwood, 1986, p.18). The transformational orientation (Figure 1b) focuses on personal and social change with three specific aims: to promote personal and social transformation; a vision of social change leading to harmony with the environment; and the identification of the spiritual dimension of the environment (Leithwood, 1986, p.20). The student is engaged on many levels, intellectually, emotionally, physically, and psychologically, interacting with the curriculum in a holistic manner.

Piaget (1973) stated, "to understand is to invent" because when you invent you are answering a question/solving a problem and thus understanding is needed. The designer begins with the end in mind and maps back from the desired result to the present to determine the best way to reach the goal, requiring an understanding of what is needed (Wiggins & McTighe, 1998, p. 146). Ideally, aim for the Spiral Curriculum – first articulated by John Dewey (1910) and developed by David Kolb (1984) as the Experiential Learning Cycle – to move back and forth between the known and the problematic, where new facts and ideas become the grounds for new experiences in which new problems are presented (Figure 2).

Figure 1: **Concepts of Orientation**

A) Transaction Position
(Leithwood, 1986, p.18)



B) Transformational Position
(Leithwood, 1986, p.20)

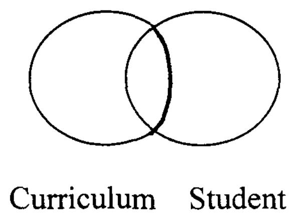
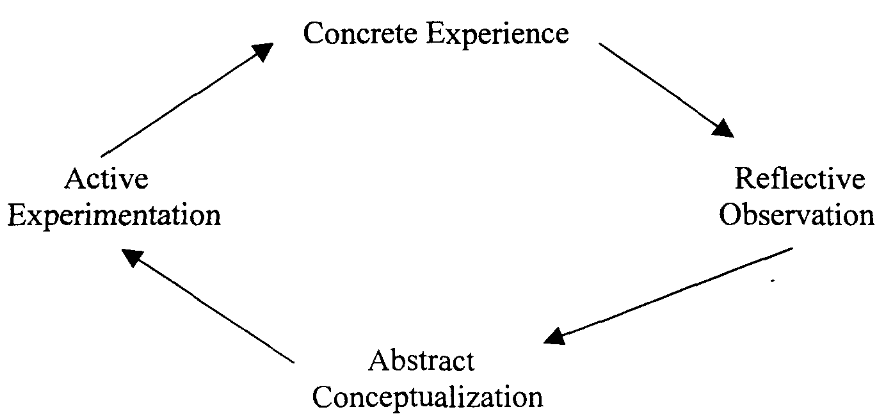


Figure 2: **The Experiential Learning Cycle**
(Kolb, 1984)



Brain research supports the Experiential Learning Cycle with the following findings:

1. Emotions are the gatekeepers to learning;
2. Intelligence is the function of experience; and
3. The brain stores most effectively what is meaningful from the learner's perspective (McGeehan, 2001, p.8)

Therefore the curriculum should build upon itself, encompassing reflection and rethinking, rather than following a linear scope-and-sequence format. In this way students self-assess and self-adjust to the changes. Spiral logic is inductive as opposed to explanatory logic which is deductive but both are needed, it is just a matter of timing; formal explanations can come after inquiry not before (or in place of) inquiry (Wiggins & McTighe, 1998, p. 153).

"Understanding is more stimulating than learning. It grows from questioning oneself and being questioned by others" (Sizer, 1984, p. 116-117). Teaching to this type of design is akin to any good practices in teaching – variety, adapting the teaching to the purpose. The didactic method is best suited to discrete skills and techniques, definitions, facts, and algorithms. Inquiry is better suited to exploring concepts and principles, anomalies, and abstract ideas. Teaching for understanding involves integrating didactic and inquiry methodologies, although the emphasis is on questioning.

Wiggins and McTighe state: "A curriculum designed to develop understanding will uncover complex, abstract, and counterintuitive ideas by involving students in active questioning, practice trying out new ideas, and rethinking what they thought they knew" (1998, p. 21), essentially following the stages of the Experiential Learning Cycle.

In any curricula, to understand a topic the student uses knowledge and skill (necessary elements of understanding). "Understanding involves the abstract and conceptual not merely concrete and discrete; concepts, generalizations, theories, and mental links between facts" (Wiggins & McTighe, 1998, p. 24). Understanding involves using the knowledge and skills in context; to be able to use the knowledge in authentic situations and understand the background of that knowledge (Wiggins & McTighe, 1998, p. 24).

Questions provide the teacher and student with a focus and better direction into inquiry into a particular topic or discipline. Using questions asks students to make meaning of selected activities and teachers develop assessment tasks to answer them. "Important ideas must be questioned and verified to be understood" (Wiggins & McTighe, 1998, p .27). In practical form this means changing content standards and outcome statements (Expectations) into question form and then designing assignments and assessments that evoke possible answers.

Essential and unit questions need to be provocative and multilayered to reveal the complexity of the subject. Essential questions:

1. point to the key inquiries and core ideas of the discipline;
2. recur naturally throughout one's learning and in the history of the field; and
3. raise other important questions (Wiggins & McTighe, 1998, p. 29,30).

Unit questions are more subject and topic-specific and better suited to framing particular content . Unit questions:

1. frame a specific set of lessons; they point to and uncover essential questions.
2. have no obvious right answer. They uncover the subjects controversies, puzzles, and perspectives.

3. are deliberately framed to provoke and sustain student interest (Wiggins & McTighe, 1998, p. 30).

The difference between an essential question and unit question is not explicit and so the emphasis should be on the ability of the question to frame the learning, engage the learner, link to more questions (general or specific), and guide the exploration and uncovering of important ideas (Wiggins & McTighe, 1998, p. 30, 31).

Curriculum designed using the Backward Design Process will result in units of study that engage students and enhance understanding, clearly defining what it is we want students to do and how they will be assessed.

CHAPTER 3

THE BACKWARD DESIGN PROCESS

Developing curricula using the Backward Design Process involves three stages (Figure 3). Stage 1 involves identifying the desired results. The following questions can be used as guides:

- What should students know, understand, and be able to do?
- What is worthy of understanding?
- What Enduring Understandings are desired? (The "big ideas", the important understandings, the things students retain after the details have been forgotten) (Wiggins & McTighe, 1998, p. 9).

The curriculum Expectations (developed by the Ministry) are used to define the desired results, although the designer interprets the given Expectations and based on their background and experience answers the questions identifying the "big ideas". Wiggins and McTighe (1998, p. 9-12) suggest using the following as filters to help in the selection of ideas and processes to teach for understanding:

1. To what extent does the idea, topic, or process represent a "big idea" having enduring value beyond the classroom?
2. To what extent does the idea, topic, or process reside at the heart of the discipline?
3. To what extent does the ideas, topic, or process require uncoverage (dealing with misconceptions or abstract ideas)?
4. To what extent does the idea, topic, or process offer potential for engaging students?

Figure 3: **The Backward Design Process Stages of Development**
(Wiggins & McTighe, 1998, p. 9)

Stage 1:
Identify
Desired
Results

Stage 2:
Determine
Acceptable
Evidence

Stage 3:
Plan Learning
Experiences
and
Instruction

Stage 2 of the Process involves determining acceptable evidence. The teacher will determine what will be accepted as evidence of student understanding and will know if the students have achieved the desired results and met the standards.

A range of assessment and evaluation tools is recommended. The unit can be anchored by a performance task or a project to assess the Enduring Understanding(s). Other assessments are used to assess essential knowledge and skills that contribute to the culminating performance(s) and they will vary in scope, time frame, setting, and structure. The collection of evidence should occur over a period of time instead of being a single event because understanding develops as a result of ongoing inquiry and rethinking, part of the Experiential Learning Cycle (Figure 2).

Wiggins and McTighe have identified six kinds of understanding (Table 1) and believe that complete and mature understanding involves the development of these facets of understanding. When we truly understand we:

- can explain
- can interpret
- can apply
- have perspective
- can empathize and have self-knowledge (what impedes our own understandings – personal style, prejudices, projections) (1998, p. 44).

These facets of understanding need to be considered when developing the assessment because "teaching for understanding aims at having students explain, interpret, and apply while showing insight from perspective, empathy, and self-knowledge" (Wiggins & McTighe, 1998, p. 64). No single lesson or unit will contain all six facets but an entire course of study would cycle through the facets. The six facets of understanding and examples of corresponding assessment strategies are provided in Table 2.

Stage 3 involves planning the learning experiences and instruction strategies. Wiggins & McTighe (1998, p. 13) suggest considering the following:

- What knowledge (facts, concepts, and principles) and skills will students need to perform effectively to achieve the desired effects?
- What activities will equip students with the needed knowledge and skills?
- What materials and resources are best suited to accomplish these goals?
- Is the overall design coherent and effective?

These questions serve as design criteria when developing the activities and instruction strategies but can also be used for peer review and self assessment of the process before and after implementation. The quality of the product is enhanced as

Table 1: **The Six Facets of Understanding**
(Summarized from Wiggins & McTighe, 1998, p. 66-67)

Facet of Understanding **A student who really understands can:**	**Characteristics**
1. explain	• qualify opinions • make good predictions • avoid common misunderstandings
2. interpret	• interpret text, language , and situations (read between the lines) • offer meaningful accounts of complex situations and people
3. apply	• use knowledge effectively in diverse and authentic/realistic contexts • self-adjust as the situation changes
4. see in perspective	• knows the history of an idea to place discussion and theory in context • knows the limits as well as power of an idea • critiques and justifies a position to see it as a point of view
5. demonstrates empathy	• has the ability to sensitively perceive • listens • project her/himself into, feel, and appreciate another's situation, affect or point of view • see and explain how an idea or theory can be all too easily misunderstood by others
6. reveals self-knowledge	• recognizes their own prejudices and style and how they colour understanding • accurately self-assesses and self-regulates • accepts feedback and criticism without defensiveness

Table 2: The Six Facets of Understanding – Instructional and Assessment Strategies
(Summarized from Wiggins & McTighe, 1998, p. 45-57)

Facet of Understanding	**Desired Result**	**Instructional Strategy**	**Assessment Tool**
Explanation	Knowledgeable and justified accounts of events, actions, and ideas	Balance between knowledge transmission and student-based inquiry	Explain by linking specific facts with larger ideas and justifying the connection(s)
Interpretations	Interpretations, narratives, and translations that provide meaning	Balance between knowledge transmission and student-based inquiry	Students draw parallels from the world at large to their own world
Application	Ability to use knowledge effectively in new situations and diverse contexts	Performance based learning	Work focuses on and culminates in authentic tasks supplemented by conventional tests
Perspective	Critical and insightful; points of view (alert to what is taken for granted, assumed, overlooked, or glossed over in an inquiry or theory)	Opportunities to confront alternative theories and diverse points of view regarding the "big ideas"	Requires students to see things from the perspective of standards, the various player, and the primary audience (not them) as they try to solve a particular problem
Empathy	The ability to get inside another person's feelings and worldview (this kind of understanding implies an existential or experiential prerequisite)	Experiential, student-based inquiry	Students confront the effects and affect of decisions, ideas, theories, and problems
Self-Knowledge	The wisdom to know one's ignorance and how one's patterns of thought and action inform as well as prejudice or limit understanding	Self-reflection: we need to understand ourselves to understand the world and to know how knowledge differs from opinion and belief	Self-reflection

teachers refine the unit designs based on feedback about strengths and suggestions for improvement. Peer review exposes people to other design models, building a repertoire from which they will build their own courses or units. My unit of study will be reviewed by the lead writer of the provincial writing team for the Grade 11 Physical Geography course, who is also the Coordinator of Social and Canadian Studies for the Halton District School Board. The Grade 11 course will be implemented in September 2001 so the "real life experiences" will not influence changes in the unit I have designed until after that date. Also because of the volume of Expectations identified by the Ministry there are only 22 hours of time allotted for the unit which does affect the allotted instructional and assessment time.

Finally when designing curriculum, a lesson, a unit of study or course, the designer needs to keep this in mind: students need to 'Do' the subject rather then just learn the material. Coverage of the curriculum means to 'travel over' and educators should aim for uncoverage, "to find value in what is hidden" (Wiggins & McTighe, 1998, p. 106) , to inspire the student to continue to question.

CHAPTER 4

DEVELOPING A UNIT OF STUDY

The first stage in developing Unit 2: Structure of the Earth (Shake, Rattle, and Roll) for the Grade 11 Physical Geography course entailed determining the desired Enduring Understandings and essential and unit questions. The course Expectations, provided by the Ministry were initially clustered by the provincial writing team. The process of clustering involved grouping the Expectations that were similar in the content to be covered and included geographic skills Expectations that would compliment and enhance the understanding of the content Expectation(s). Five units were identified in this process: Unit 1: Planetary Systems – A Quest for Balance; Unit 2: Structure of the Earth; Unit 3: Gradational Processes; Unit 4: Weather and Climate; and Unit 5: an Independent Field Study. I took the cluster of expectations for Unit 2, taking into account what students were expected to learn and understand and answered the following questions, developed by Wiggins & McTighe (Table 3):

- What Enduring Understandings are desired?
- What are the overarching essential questions?
- What essential and unit questions will focus this unit?
- What will students understand as a result of this unit?

Determining the Enduring Understandings (overarching understandings) was the most challenging aspect of developing the unit. It was enlightening for me because I had to ask myself : What is important and why? Do students really need to understand about the structure of the Earth? This challenged my understanding of why I am a

Table 3: Stage 1: Identifying the Desired Results.

Question: What Enduring Understandings are desired? The Earth is more than an oblate spheroid, it is a dynamic entity of which people have a vested interest in understanding and sustaining. (Why does humankind need to understand and sustain the Earth? How was it made? What is it made of? How does it change and what are the rates of change? People use the resources and there are examples of adaptation in nature that can stimulate peoples' creativity to perpetuate the existence of humankind).
Question: What are the essential questions? • Why is there an Earth? How has the Earth come to be? • Why is the physical landscape constantly changing? • Is the Earth sustainable?
Question: What essential and unit questions will focus this unit? • How has the Earth evolved geologically? • What is the structure of the Earth? • What natural forces are at work changing the physical landscape? • What are the results (positive and negative) of changes to the physical landscape? • What can people do to ensure a sustainable physical environment?
What will students understand as a result of this unit? Students will understand: • how the Earth came to be and how it is constantly changing as a result of natural forces; • how the changes on the Earth's physical landscape influence people positively and negatively; and • the importance of humankinds need to care for (stewardship) and sustain the physical environment for today and future generations.

Geography teacher? Once I had answered the personal questions and developed the unit questions, the assessment strategies and then the instructional strategies fell into place.

The next step was to develop a summary chart connecting the Ministry curriculum Strands (headings used to organize the Expectations) and Expectations and the unit questions I had developed (Table 4). This meant clustering the Expectations that would address each unit question. Each Expectation is coded (by the Ministry) to designate the respective Strand to which it belongs. There are five Strands in the course: Geographic Foundations: Space and Systems; Human-Environment Interactions; Understanding and Managing Change; and Methods of Geographic Inquiry. This step was easy because the Expectations were the foundation of developing the questions, it was only a matter of selecting the Expectation(s) that best answered the question.

Stage 2 of the Backward Design Process involved determining acceptable evidence to assess and evaluate the expectations and understandings. The first step involved determining what sector of the Achievement Chart Category each expectation corresponded to. The Achievement Chart Categories (developed by the Ministry) include: Knowledge/Understanding (K), Communication (C), Thinking/Inquiry (T), and Application (A) (Table 5). The Achievement Chart Categories are determined by identifying the verb(s) in each Expectation and determining which of the four categories is being addressed. In some cases two achievement categories may be selected. This is demonstrated in Table 5 where K/C appears. This indicates that the Expectation includes a knowledge and/or communication component. The task of designating the achievement category represented by each Expectation can be challenging.

Table 4: Unit Questions, Strands, and Expectations.

Question: How has the Earth evolved geologically?

Strands:	Geographic Foundations: Space and Systems Understanding and Managing Change
Overall Expectations	
SSV.01	explain major theories of the origin and internal structure of the Earth
SSV.02	demonstrate an understanding of the principal features of the Earth's major components: the lithosphere, atmosphere, hydrosphere, and biosphere
Specific Expectations	
UC1.01	describe the difference between the human and geologic time scales

Question: What is the structure of the Earth?

Strands:	Geographic Foundations: Space and Systems Human-Environment Interactions Methods of Geographic Inquiry
Overall Expectations	
SSV.01	explain major theories of the origin and internal structure of the Earth
Specific Expectations	
SS2.01	describe the components of the internal structure of the Earth (core, mantle, crust)
SS2.02	differentiate among the major rock types (igneous, sedimentary, metamorphic) and explain their origins
HE1.01	explain why certain geological formations contain rich mineral deposits
GI1.02	demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth
GI2.03	produce and interpret maps, diagrams, charts, and models

Question: What natural forces are at work changing the physical landscape?

Strands:	Geographic Foundations: Space and Systems Global Connections Understanding and Managing Change Methods of Geographic Inquiry
Overall Expectations	
SSV.04	explain the physical processes that create landforms, climate, soils, and vegetation
GCV.01	analyze the global distribution of landforms, climate, soils, and vegetation to determine reasons for the observed distribution patterns

Specific Expectations

SS1.03	explain the physical evidence found on the surface of the Earth and at the bottom of the oceans that supports the theory of plate tectonics
SS1.07	describe the rates at which different physical processes occur (e.g., continental erosion, soil formation, tectonic uplift)
SS2.03	explain the role that convection currents are believed to play in the motion of the Earth's crustal plates
SS2.04	analyze the global distribution of major physical features (e.g., Ring of Fire, mountain systems, tectonic plates) and determine reason for the observed patterns
SS3.01	interpret the spatial relationships between mountain ranges, occurrences of earthquakes, and tectonic plate boundaries and explain the processes believed to be at work
SS3.02	characterize the difference between continental and oceanic plates and demonstrate an understanding of the processes at work in the boundaries between them
UC1.01	demonstrate an understanding that the world's surface is dynamic, in that it is constantly being shaped (e.g., mountain building, erosion)
UC1.05	identify and describe the mechanisms for change within the lithosphere, atmosphere, hydrosphere, and biosphere
GI1.02	demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth
GI2.03	produce and interpret maps, diagrams, charts, and models

Question: What are the results (positive and negative) of changes to the physical landscape?

Strands: Human-Environment Interactions
Understanding and Managing Change
Methods of Geographic Inquiry

Specific Expectations

HE1.02	demonstrate an understanding of the trade-offs for humans living in areas subject to natural disruptions (e.g., coastal zones, slopes of active volcanoes, regions of tectonic activity such as California and Japan)
HE2.01	explain the roles of volcanoes and river estuaries in providing fertile soils for agriculture
HE2.02	analyze the effects of environmental hazards (e.g., earthquakes, hurricanes, landslides) on human activities
UC3.06	predict both positive and negative impacts of tectonic change and climate change (e.g. earthquake risks, temperature increases) on their local community
GI1.02	demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth
GI2.03	produce and interpret maps, diagrams, charts, and models

Question: What can people do to ensure a sustainable environment?

Strands:	Human-Environment Interactions Global Connections Methods of Geographic Inquiry
Overall Expectations	
HEV.04	demonstrate an understanding of the importance of stewardship and sustainability as guiding principles for human use of the physical environment
Specific Expectations	
GC1.04	identify local, regional, and global issues related to physical geography
GC2.02	explain the relationships that link global patterns of landforms, climate, soils, and vegetation to each other
GC3.03	identify geopolitical issues that face nations that share various physical regions of the world (e.g., circumpolar regions, the Sahel, the Nile Valley)
GI2.03	produce and interpret maps, diagrams, charts, and models

Table 5: Summary Chart of Unit 2: Structure of the Earth
(Shake, Rattle, and Roll)

Introduction:
The Earth is more than an oblate spheroid, it is a complex and dynamic mosaic of systems of which man has a vested interest in understanding and sustaining. Why is there an Earth? How has the Earth come to be? Why is the physical landscape constantly changing? Is the Earth sustainable? These are the essential questions. In this unit students will learn how the Earth has evolved and how it is constantly changing as a result of natural forces. Students will examine the Earth's physical landscape and identify the consequences of the changes, positive and negative. People's responsibility as a steward/caretaker and a manager, for sustainability, of the physical environment will be emphasized.

Cluster Number	**Expectations**		**Assessment (Achievement Chart Category)**	**Focus**
	Overall	**Specific**		
1	SSV.01 SSV.02	UC1.01	K K/C C	**How has the Earth evolved geologically?** • review theories of origin of the Earth human and geologic time scales
2	SSV.01	SS2.01 SS2.02 HE1.01 GI1.02 GI2.03	K/C C T A	**What is the structure of the Earth?** • internal structure of the Earth • rock types • mineral deposits • measuring, mapping, and imaging features of the Earth (technology) use of maps, diagrams, charts, and models
3	SSV.04 GCV.01	SS1.03 SS1.07 SS2.03 SS2.04 SS3.01 SS3.02 UC1.01 UC1.05 GI1.02 GI2.03	K K/C T A	**What natural forces are at work changing the physical landscape?** • physical processes creating landforms (e.g., plate tectonics) • global distribution of landforms • rates and mechanisms for change • measuring, mapping, and imaging features of the Earth (technology) • use of maps, diagrams, charts, and models

4		HE1.02 HE2.01 HE2.02 UC3.06 GI1.02 GI2.03	K K/C T A	**What are the results (positive and negative) of changes to the physical landscape?** • effects of environmental hazards on human activities • local impacts • measuring, mapping, and imaging features of the Earth (technology) • use of maps, diagrams, charts, and models
5	HEV.04	GC1.04 GC2.02 GC3.03 GI2.03	K K/C T A	**What can people do to ensure a sustainable physical environment?** • stewardship and sustainability • local, regional, and global issues • system relationships • use of maps, diagrams, charts, and models

There are reference charts (Table 6) that are used to help in the determination of the achievement category but the identifying verb can fall in two categories (e.g., compare K/C; contrast K/T). In developing the achievement categories for this unit I included all possible categories to provide as much flexibility as possible.

Using the unit questions and the key aspects of the clustered Expectations for each question I developed assessment tasks to address the understandings. It is interesting to note that the six facets of understanding as outlined by Wiggins & McTighe (1998) correspond readily with the Ministry Achievement Chart Categories:

Wiggins & McTighe Six Facets of Understanding:	Ministry Achievement Chart Categories:
• Explanation	Knowledge
• Interpretation	Thinking and Inquiry
• Application	Application
• Perspective	Communication
• Empathy	
• Self-Knowledge	

Both formative assessment (ongoing) and summative evaluation strategies are provided. Formative assessment tools allow the student to practice skills and their understanding of concepts before they are evaluated (graded), providing feedback to the student on what they are doing well and where improvement is needed. The teacher also uses the feedback to direct the development of opportunities for students to practice the needed skills or develop an understanding of concepts. It is not necessary to have a formative assessment and summative evaluation for each activity. A formative assessment may be included to determine that the student has maintained a skill or

Table 6: Action Verbs Organized by Achievement Level Categories
(Adapted from Brydges, 1999, Section 3)

Knowledge/ Understanding	**Thinking/Inquiry**	**Communication**	**Application**
Classify	Analyze	Articulate	Apply
Compare	Apprasie	Clarify	Connect
Complete	Assess	Compare	Create
Connect	Classify	Describe	Demonstrate
Contrast	Conclude	Engage	Develop
Define	Contrast	Explain	Display
Distinguish	Differentiate	Justify	Estimate
Identify	Examine	Present	Evaluate
Label	Inquire	Propose	Exhibit
Locate	Investigate	Reflect	Integrate
Rate	Predict	Respond	Modify
Recognize	Prioritize	Teach	Participate
Structure	Reflect	Write	Perform
	Research		Produce

understanding (Expectation) previously taught (Appendix 1: Activity 2B) or to practice and assess a new skill or concept being introduced (Appendix 1: Activity 2A). If no formative assessment is included it may be that the Expectation has been assessed and/or evaluated previously in the unit. In some instances formative assessment is included to keep the student and teacher informed that the required work is being completed (Appendix 1: Activity 2C). The summative evaluation is used to determine the grade and occurs after the student has had the opportunity to develop the required skill(s) and understanding(s). This is a crucial process for the assessment and evaluation strategies need to address the Expectations and the corresponding Achievement Chart Categories.

Stage 3 involved the development of the activities, refinement of the instructional strategies to engage and equip students with the knowledge and skills to achieve the expectations resulting in curriculum for understanding. The activities numbered 1 through 5, correspond to the cluster number and unit questions (Table 5) and are included in Appendix 1. The structure/format for each activity is consistent with that used by the provincial writing team for Unit 1. I included some support material to reduce teacher preparation time in developing materials (e.g., Activity 1: Visualizing Geological Time) and assessment tools. The allotment of 22 hours for the unit will be difficult for implementation because not all students have easy access to technology. There are many Expectations, one entire Strand, Methods of Geographic Inquiry that relies heavily on access to Geographic Information systems (GIS), satellite imagery, the internet, and mapping and graphing skills. Each teacher will need to make adjustments to the activities based on their resources, although the Ministry Expectations must still be met.

Availability of resources is always a concern and no money has been allocated by the Ministry for textbooks for the new Grade 11 courses which will lead to inequality in resources from school to school within the province. I have provided references to resources to help teachers in their quest for materials to support the unit work.

This unit will be implemented in September 2001 at high schools in Ontario. I am not able to provide feedback based on implementation but the peer reviewer (lead writer of the Grade 11 Physical Geography provincial writing team) provided the following feedback:

1. The unit questions guiding the learning are clearly stated and the accompanying activities are designed to direct the students in the inquiry process.
2. The Enduring Understandings are the key to designing the unit and could be reviewed at various stages through the unit, to assess the success of the activities and assessment strategies being utilized.
3. A considerable amount of non-school time is required on the students behalf to complete assignments (e.g., Appendix 1: Activity 3B producing a model of a selected plate boundary) therefore the preparation and timing of assignments will need to be scheduled to accommodate this.
4. The assessment and instructional strategies were congruent with Wiggins and McTighe's designing curriculum for understanding, engaging the students to explore and apply knowledge and skills in an authentic context.

This unit of study will be stimulating for the students and the teachers.

CHAPTER 5

CONCLUSION

The Backward Design Process allows teachers to make learning and understanding authentic. Students are impelled to not just to 'know' facts but understand why pieces of information are facts and what those facts mean in a greater context of a discipline and the Earth (human and physical).

The most challenging and important aspect of developing Unit 2 was determining the Enduring Understandings. This step involved considering the Ministry Expectations and determining the underlying meanings behind the particular cluster of Expectations. From this the unit questions were developed followed by the assessment strategies and then the instructional strategies. The key difference in the Backward Design Process when compared to other curriculum development models is the instructional strategies (activities) are designed last, after the Enduring Understandings and assessment and evaluation strategies have been determined. This removes teacher bias from designing curriculum to accommodate certain lessons or use of preferred resources. The curriculum is designed to address the Expectations and Enduring Understandings.

Although the unit has been designed the process is not finished. The entire course profile will be field tested in September 2001, including Unit 2: Structure of the Earth (Shake, Rattle, and Roll). At the end of the fall term (January 2002) the Halton teachers of the Grade 11 Physical Geography course will provide feedback to the Halton Grade 11 Development Team on the effectiveness of the entire course profile. The teachers will be asked to consider the following:

1. Were the desired results/Enduring Understandings made clear?
2. Was the required evidence (assessment and evaluation) reflective of the desired results/Enduring Understandings?
3. Did the learning experiences and instruction strategies provide opportunities for students to develop an understanding of the desired results/Enduring Understandings?

The recommendations will be available to the teachers for the winter term (February-June 2002).

Development of this unit has increased my understanding of creating curriculum that really addresses what is important for students to not just learn (e.g., memorize facts) but truly understand. Taking theory and applying it/putting it into practice is the ultimate test of the usefulness, applicability and credibility of the premises set forth. I now understand how the Ministry course profiles for Grades 9 and 10 were designed and will be able to adjust them as needed with confidence now that I know what is being asked of the student and in turn myself.

As a result of writing Unit 2 I have been asked to be a member of the Halton writing team to complete the Grade 11 Physical Geography course profile, units 3,4,and 5. The units will be shared with other Ontario school boards. I have supported Halton teachers in developing the overview for the Grade 11 Regional Geography: Travel and Tourism course (CGG 3O Open) using the Backward Design Process. In addition I will be developing the exemplars (examples that illustrate and clarify levels of student performance expected in relation to curriculum Expectations) for the Grade 11 Americas: Geographic Patterns and Issues (CGD 3M University/College) with a Ministry writing team in August 2001.

Learning/understanding by doing is what the Backward Design Process promotes with clearly defined results. I have followed the process and developed an understanding of it and believe it is an exemplary model for designing curriculum for understanding.

Teachers in Ontario should be given formal training in the Backward Design Process so they can implement the new curricula with confidence and understanding. Teachers need to understand the process used in developing the course profiles in order to implement the curricula and achieve the desired results.

The Backward Design Process aims to address what every teacher wants their students to achieve: an understanding of what is important and the inspiration to ask more questions.

APPENDIX 1: Unit Activities

Activity 1 **HUMAN and GEOLOGIC TIME SCALES**
1.2 hours (70 minutes)

DESCRIPTION

This activity addresses the question: How has the Earth evolved geologically?
In Unit 1 students learn about the theories explaining the origin of the universe. In this lesson students will study the geologic time scale and learn about the major geologic events in the development of the Earth. The biological and human dimension will be incorporated to provide perspective.

STRAND(S) and EXPECTATIONS

Strands: Geographic Foundations: Space and Systems
Understanding and Managing Change

Overall Expectations

SSV.01 explain major theories of the origin and internal structure of the Earth;
SSV.02 demonstrate an understanding of the principal features of the Earth's major components: the lithosphere, atmosphere, hydrosphere, and biosphere;

Specific Expectations

UC1.01 describe the difference between the human and geologic time scales.

PRIOR KNOWLEDGE and SKILLS

The theories explaining the origin of the universe would have been studies in Unit 1.

PLANNING NOTES

A tape recorder is needed if background music is provided.

TEACHING/LEARNING STRATEGIES

1. Present the Geological Time Scale highlighting the major geologic and biologic developments (e.g., Devonian – mountain building in eastern North America (Acadian orogeny) and biologically the first amphibians and an abundance of fish). A useful diagram is the found in the booklet: Toronto Rocks – the Geological Legacy of the Toronto Region (cited in Resources). The authors use the CN Tower as the scale for linking the geologic development of the area to the geological time scale. Most students will be familiar with the CN Tower and could adapt the diagram to reflect the geologic events in their area.
2. A guided visual imagery activity using the human scale of a year/12 months or a day/24 hours to guide the students through the geologic time scale will provide them with a perspective of the magnitude of time that the geologic time scale represents (4.6 billion years). A sample is provided. The video – Geologic Time provides a

comparison of human and geologic time scales as well as information of geologic dating (cited in Resources).

ASSESSMENT and EVALUTION

1. Formative Assessment – students will extend the guided imagery activity of what the Earth will be like in the next two hundred years. They will write a page describing it or draw a picture to support their predictions. The predictions should include both human and environmental developments.
2. Summative Evaluation – after completing the predictions (written or pictorial) the students will write a paragraph explaining the difference between the human and geologic time scales.

ACCOMMODATIONS

The written components of the assessment and evaluation could also be tape recorded for an oral response. A computer generated picture could replace the pictorial prediction.

RESOURCES

Print: Eyles, N. and Clinton, L. *Toronto Rocks – The Geological Legacy of the Toronto Region.* Toronto: University of Toronto, 1998.

Video: Magic Lantern Communications Ltd. *Geologic Time*. (Available from Magic Lantern Communications Ltd., #38-775 Pacific Road, Oakville, Ontario L6L 6M4).

Electronic: *Basics – Geologic Time*. (17 April 2001). [On-Line]. Available: http;//geology.about.com/science/geology/library/bl/blbasics_time.htm

VISUALIZING GEOLOGIC TIME

Our ideas about time are very much affected by the length of the average human life time and it's subdivision into periods (such as infancy, youth, adolescence, maturity, middle age, etc.) and into years. The term "one million years" is so far outside our everyday experiences as to be almost meaningless to us. We have the vague impression that a million years is "a very long time", and that a billion years is a "very, very long time". But even the birth of The Christian Era, almost 2000 years ago, would be considered to be a very long time ago also! Indeed, all periods longer than a human lifetime, or two, have a tendency to fade into the "very long time ago" category for most of us.

The length of a year and it's subdivisions into months, weeks, days, hours, minutes and seconds is not too difficult to be understood. So if we try to compress the long span of geologic time into the familiar subdivisions of a year, we can get some idea of the length of out existence on this Earth. Try to imagine a moving picture taken of the history of the Earth from it's creation to the present using a time-lapse camera. If this imaginary film was taken at a rate of one picture per year and shown at a normal speed (24 pictures per second), 24 years of Earth history would flash by on the silver screen each second. Since the film would run continuously 24 hours a day, about 200 million years of the geologic past would be shown on the screen each day. To show the last 800 million years of Earth history would require us to run the film for one full year (probably a Guiness World Book Record!).

So let's start the film at the 800 million years ago point on midnight of New Year's Eve and run it without interruption until midnight of the next New Year's Eve and watch the history of the Earth unfold before us.

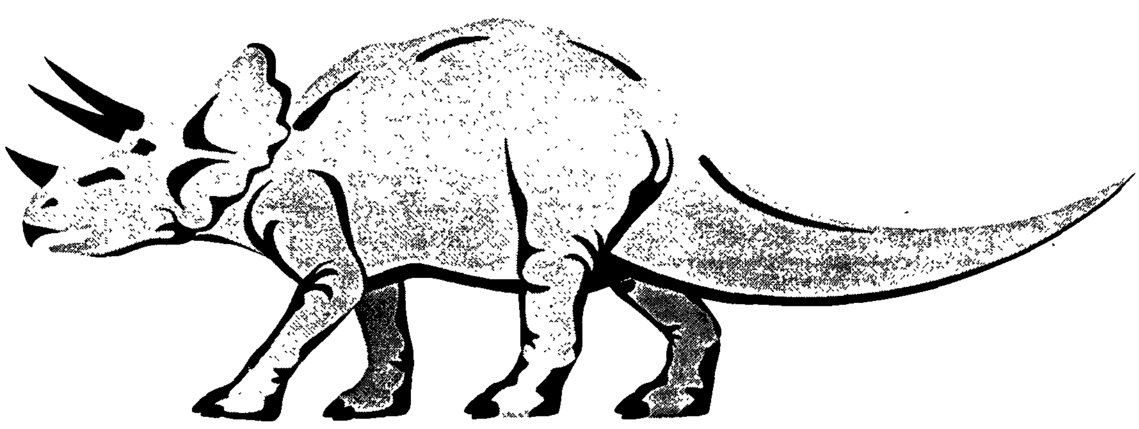
Throughout the months of January, February, and March, the scenes of Earth look bleak, showing absolutely no signs of life as we know it. No organisms are to be detected by even the most careful observations or microscopic studies. The first stirrings of life, simple single-celled microorganisms, appear early in the month of April and the unique story of life in our solar system begins. By the last week in April, multi-celled organisms arrive on the scene through the miracle of evolution. These life forms continue to change and evolve until the first vertebrates are found by the last week of May. By the middle of July, the first plants begin the colonization of the continents, abandoning the sea for the first time, another milestone in the march of evolution. In late August, the first land vertebrates, the amphibians, put in an appearance and flourish. The first reptiles appear by the middle of September. From these early ancestors, the dinosaurs rise quickly to dominate the scene from the latter part of September through October and much of November, a period of about 70 days. This establishes them as one of the most successful, diverse and long lived to ever inhabit the Earth. The first birds and mammals also appear in the third week of November. The last week of this month is marked by a number of significant changes. The raising of the Rocky Mountain system in North America, (and the Alps in Europe and the Himalayas in Asia) signals in the end of the great era of reptilian domination. The demise of the dinosaur remains one of the great mysteries of all time and many would be scientific Sherlock Holmes' have tried to explain why they became extinct so suddenly at this time. Since we dozed off briefly during this part of the movie (after all, the dinosaurs really took up a long part of the movie), we may have missed one of the great catastrophes of all time: the collision of a large meteor or comet with the Earth. Our brief slumber has left us to speculate on the possibility that such an impact did occur.

As the movie continues to run into December, the mammals come to dominate the life forms of the planet; they undergo their great evolutionary developments in the weeks leading up to the Christmas holidays. As Christmas day arrives, we see the Colorado River beginning to cut downward into the rising Colorado Plateau to form the Grand Canyon. We have the vague and uneasy idea that the year, and our panoramic movie, are both nearing their end and as yet we have seen no sign of human beings or anything resembling them. Day follows day until we reach the last day of the year: December 31. The morning hours of the last day also pass without any

VISUALIZING GEOLOGIC TIME

debut. Then suddenly, about noon hour on December 31, the first primitive human beings pop up in the grasslands of East Africa. Our interest is diverted about 1 p.m. by the advance of glaciers from the northern and southern polar regions. These glaciers advance, then retreat, four successive times over North America and Western Europe. Our sightings of human activity is very scanty, even as late as suppertime (6 p.m.). As we move close to the beginning of the "New Year", about 11 p.m., to be more precise, the "Old Stone Age" begins and we see more evidence of human activity on the Earth. By 11:45 p.m., the prominence of human beings is well established as refined stone implements are being produced. At 11:50, the Neolithic revolution occurs, the first conscious cultivation of the soil to produce food takes place in key river valleys in the Middle East. At 5 minutes to midnight, we see the dawn of civilization in the Mesopotamia region, followed quickly by similar developments in Egypt, the Indus valley and the Mediterranean Basin. One minute and 17 seconds before the end of our movie, the Christian Era begins. As the clock ticks quickly down, Columbus discovers America with 20 seconds left. Seven seconds before the end, the Canadian Confederation is formed. With less than two seconds left the Vietnam War starts and ends.

Many aspects of this wonderful and imaginary movie are worth thinking about, if only briefly. Life has existed on Earth for some 8 months of the movie's year; human beings were present for about 12 hours of that year. The dinosaurs dominated the movie for 70 days; human beings for only half a day, so far. Yet sometimes we hear comments that the dinosaurs were "unsuccessful" animals! If the movie continues into the future, what will it show? Will it show us here seventy days from now??? Even considering we have been on Earth for 12 hours of the imaginary year, we have only had any civilization considered worthy of that term for 5 or 6 minutes. This is sometimes a comforting thought when we become impatient with the "slow" progress made by human beings in adopting new ideas or reforms. In speaking of such progress as "slow" we are using human lifetimes as our measuring stick. Measured by the history of the Earth, $4^1/_2$ billion years, our progress since the dawn of civilization has been dazzlingly swift compared to the pace of normal evolution.



Activity 2A **INTERNAL STRUCTURE of the EARTH**
1.2 hours (70 minutes)

DESCRIPTION
The activities in this sequence address the question: What is the structure of the Earth? Students will begin by examining a diagram identifying the structure of the Earth and research to determine the characteristics of each of the areas (e.g., crust/lithosphere). Understanding the internal structure will provide the foundation to explain the origin of the rock types and the theory of plate tectonics.

STRAND(S) and EXPECTATIONS
Strands: Geographic Foundations: Space and Systems
Methods of Geographic Inquiry
Overall Expectations
SSV.01 explain major theories of the origin and internal structure of the Earth;
Specific Expectations
SS2.01 describe the components of the internal structure of the Earth (core, mantle, crust);
GI2.03 produce and interpret maps, diagrams, charts, and models.

PRIOR KNOWLEDGE and SKILLS
Orgin of the Universe and the Solar System.

PLANNING NOTES
Prepare the diagram of the internal structure of the Earth.

TEACHING/LEARNING STRATEGIES
1. Students will the label the diagram of the internal structure of the Earth provided by the teacher. The following terms should appear on the diagram: crust/lithosphere, asthenosphere, mantle/mesosphere, core – inner and outer, and the Mohorovicic Discontinuity.
2. Students will then determine the characteristics of each of the areas.

ASSESSMENT and EVALUATION
1. Formative Assessment – in students will complete a diagram showing the components of the internal structure of the Earth. Also students will be engaged in a question and answer session to determine their understanding of the material.

2. Summative Evaluation - in groups students will prepare an oral presentation identifying the components of the internal structure of the Earth and provide an explanation of the origin of the Earth. Students will also use one or more of the following: diagrams, charts, maps, and/or models to support the topics.

ACCOMMODATIONS

Students can submit their written work (notes) instead of engaging in the question and answer session.

RESOURCES

Print: Keller, E. A. *Environmental Geology (5th Ed.)*. Toronto: Merrill Publishing Company, 1998.

Electronic: *Earth Science Basics*. (17 April 2001). [On-Line]. Available: http://geology.about.com/science/geology/cs/escibasics/index.htm

Activity 2B **ORIGIN and COMPOSITION of the MAJOR ROCK TYPES**
4 hours (240 minutes)

DESCRIPTION
Students will have a "hands on" experience reviewing the rock cycle and identifying and classifying igneous, sedimentary, and metamorphic rocks.

STRAND(S) and EXPECTATIONS
STRANDS: Geographic Foundations: Space and Systems
Methods of Geographic Inquiry

SPECIFIC EXPECTATIONS

SS2.02 differentiate among the major rock types (igneous, sedimentary, metamorphic) and explain their origins;

GI2.03 produce and interpret maps, diagrams, charts, and models.

PRIOR KNOWLEDGE and SKILLS
The definitions and connections between elements, minerals, and rocks.
The physical characteristics to identify minerals and Moh's Hardness Scale and the designate minerals.

PLANNING NOTES
Prepare a rock cycle diagram. Videos of each rock type are available from Magic Lantern Communications Ltd., Oakville (Resources) and questions can be generated to direct the students while viewing the videos. Also rock kits are available from Ward's Natural Science Establishment, New York (Resources) and worksheets will need to be developed to direct the students learning. Local geologists or members of local rock and gem clubs are good resources for samples and also as guest speakers.

TEACHING/LEARNING STRATEGIES
1. Students will label the diagram of the rock cycle identifying the rock types (igneous, sedimentary, metamorphic) and the process(es) that are involved in their formation (e.g., solidification, heat and pressure) and destruction (e.g., erosion and transportation).
2. Students will watch a video covering each rock type (cited in Resources) and complete the accompanying questions. They will also complete a worksheets/chart for each rock type. The students will learn how to differentiate between igneous, sedimentary, and metamorphic rocks. A distributor for rock kits is cited in Resources.

Sample Igneous Rock Kit Worksheet:

Rock #	Overall Colour (light, intermediate, dark)	Density (low, medium, high)	Texture (aphanitic phaneritic porphyritic)	Identitites of dark Minerals	Types of feldspars	Other features	Rock Name (and origin)
#2	*light*	*low*	*aphanitic (porous)*	*biotite*	*potassium feldspar*	*porous layers*	*pumice (volcanic ash)*

Sample Sedimentary Rock Kit Worksheet:

Rock #	Reaction with diluted HCL	Texture (clastic; non-clastic: crystalline or organic)	Grain Size Course (2mm diameter) Medium (1/10-2mm) Fine (<1/10mm)	Composition (minerals, rock fragments, or fossil fragments)	Other Features	Rock Name	Depositional Environment (origin)
#17	*yes*	*clastic*	*fine*	*quartz*	*reddish (Fe)*	*sand-stone*	*ancient sea close to shore*

Sample Metamorphic Rock Kit Worksheet:

Rock #	Texture (foliated , non-foliated)	Grain Size Course (2mm diameter) Mediun (1/10-2mm) Fine (<1/10mm)	Composition (minerals in decreasing abundance)	Rock Name	Probable original rock type before metamorphism
#25	*Non-foliated*	*medium*	*quartz feldspar biotite magnetite*	*biotite gneiss*	*granite*

ASSESSMENT and EVALUATION

1. Formative Assessment – completion of all three rock kit worksheets.
2. Summative Evaluation – a "hands on" test using real rock samples and where students identify a minimum of three rocks from each of the rock types using the characteristics from the worksheets. Include the rock cycle for the students to label. It is best to set up stations that the students rotate through identifying the rock at each station.

ACCOMMODATIONS

Students can move through the test with the teacher and orally complete the test.

RESOURCES

Videos: Magic Lantern Communications Ltd. Videos Series: *Materials of the Earth (Minerals; and Igneous, Sedimentary, and Igneous Rocks).* (Available from Magic Lantern Communications Ltd., #38-775 Pacific Road, Oakville, Ontario L6L 6M4).

Rock Kits: Ward's Natural Science Establishment. *Igneous, Sedimentary, and Metamorphic Rocks (Reference Kits).* New York: Ward's Natural Science Establishment, Inc., 1994.

Electronic: *Rock Types and Stone Stuff.* (17 April 2001). [On-Line]. Available: http://geology.about.com/science/geology/cs/rock_types_n_stone/index.htm

Activity 2C
2 hours (105 minutes)

Mineral Deposits – Where and Why?

DESCRIPTION

Students will identify rocks and their associated mineral deposits. They will produce a map identifying the deposits in Ontario.

STRAND(S) and EXPECTATIONS

STRANDS Human-Environment Interactions
Methods of Geographic Inquiry

SPECIFIC EXPECTATIONS

HE1.01 explain why certain geological formations contain rich mineral deposits

GI1.02 demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth

PRIOR KNOWLEDGE and SKILLS

Students will review the notes they made from watching the previous videos on igneous, sedimentary, and metamorphic rocks.

TEACHING/LEARNING STRATEGIES

1. Students will complete the following chart.

Rock Type	**Associated Mineral Resources and Uses**	**Probable Origin**
e.g., Sedimentary	oil, gas, natural gas (fuel)	ancient sea – microscopic organisms died and compacted
	sand and gravel (buildings and roads)	glacial meltwater - streams and eskers

2. Produce a map of Ontario locating the main (profitable) mineral deposits. Describe in general terms where the deposits are and the geologic situation in which they are found. Identify any patterns that emerge to explain their occurrence.

ASSESSMENT and EVALUATION

1. Formative Assessment - complete the chart.
2. Summative Evaluation - a map rubric (provided) to evaluate the map and a rubric to evaluate the accompanying description of the deposits and the geological situation of the deposit as well as the identification of patterns to explain the deposit occurrence.

ACCOMMODATIONS

All the work could be completed on the computer or by hand depending on the equipment available to the student and the student's own skills.

RESOURCES

Print: Christiansen, E. H., and Hamblin, W. K. *Earth's Dynamic Systems (8th Ed.).* New Jersey: Prentice-Hall, 1998.

Levin, H. L. *Contemporary Physical Geology (2nd Ed.).* Toronto: Sanders College Publishing, 1986.

Electronic: *Canadian Centre for Remote Sensing.* (18 April 2001). [On-Line]. Available: http://www.ccrs.nrcan.gc.ca/

Mineralogy. (17 April 2001). [On-Line]. Available: http://geology.about.com.science/geology/cs/mineralogy/index.htm

Rock Types and Stone Stuff. (17 April 2001). [On-Line]. Available: http://geology.about.com/science/geology/cs/rock_types_n_stone/index.htm

MAPPING RUBRIC

Student's Name: ______________________
Map Topic: ______________________
Evaluator:
Teacher: ______________________
Peer: ______________________
Self: ______________________

Title Checklist	• Printed neatly • Located at top of page • Underline or highlighted in a box • Clearly reflects the topic				___ / 2
Legend Checklist	• Positioned in an appropriate area • Quality of construction • Accuracy of labels and symbols • Useful to the reader				___ / 2
Labels Checklist	• Printed neatly • *Aligned carefully* • Spelled accurately				___ / 2
Criteria	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Mark Assigned**
Directional (or North Arrow / Compass Rose)	Included: in-accurate and untidy	Included: Inaccurate, but neat	Included: accurate, but untidy	Included: accurate and neat	___ / 1
Appearance • Appropriate use of colour • Consistent shading • Use of ruler to create straight lines and/or frame (if applicable)	Ineffective use of colour, shading and/or ruler	Moderately effective use of colour, shading and/or ruler	Considerably effective use of colour, shading and/or ruler	Extremely effective use of colour, shading and/or ruler	___ / 3
Accuracy of Features Mapped	Features have been mapped with limited accuracy (more than 5 errors)	Features have been mapped with moderate accuracy (4 to 5 errors)	Features have been mapped with considerable accuracy (2 to 3 errors)	Features have been mapped with great deal of accuracy (0 to 1 error)	___ / 5
Overall Achievement Level					Mark: ___ / 15

Activity 3A **Continental Drift to Plate Tectonics**
2 hours (70 minutes)

DESCRIPTION

The sequence of lessons and activities in this section address the question: What natural forces are at work changing the physical landscape? In this lesson students will review the development/evidence of the theory of continental drift as presented by Alfred Wegener. Then the teacher will provide the progression of events and developments that led scientists (Harry Hess, F. Vine, d. Matthews, L.W. Morley) to propose the theory of plate tectonics used to explain the dynamic nature of the Earth (volcanism, earthquakes, mountain building, faulting and folding).

STRAND(S) and EXPECTATIONS

STRAND Geographic Foundations: Space and Systems

SPECIFIC EXPECTATION

SS1.03 explain the physical evidence found on the surface of the Earth and at the bottom of the oceans that support the theory of plate tectonics

GI1.02 demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth

PRIOR KNOWLEDGE and SKILLS

Students should have an awareness of Alfred Wegener and the theory of Continental Drift.

PLANNING NOTES

This will be an autocratic lesson with support diagrams and models where possible. With access to Microsoft Power Point many visual resources can be downloaded and used in place of overheads. Lessons 3A, 3B, and 3C cover the topic of plate tectonics and the allotted time per lesson is only a guideline however the teacher should keep to the overall allotted time.

TEACHING/LEARNING STRATEGIES

1. The theory of Continental Drift (that the continents were all once joined in a supercontinent (Pangaea) which then split and the continents drifted to their present day position) is presented with the accompanying evidence that Alfred Wegener used to support his idea. The evidence including: continental fit, rock sequences and mountain ranges; glacial remnants; paleoclimates; fossils (animals and plants); and

paleomagnestism and polar wandering. As mentioned in the planning notes visual support is useful to help convey the evidence, references are cited in resources.

2. With the mapping of the ocean floor scientists discovered a ridge system dividing the ocean floor. Through sampling ocean floor material scientisits discovered the ocean basins were younger then the continents consisting mainly of basalt, much different then the continents. Also the ocean crust was found to be thinner then that of the continents. In 1962 Harry Hess, a geologist from Princeton University, proposed that sea-floor spreading could account for continental movement. Paleomagnetic data was used to confirm Hess's proposal. The proposal of sea-floor speading provided the mechanism for continental drift and the development of the theory of plate tectonics. This information can be presented in lecture style with accompanying visuals especially of convection cells and paleomagnetic data (reversals).
3. Label the continents on a map of Pangaea (250 million years ago before they broke up) and on another map label the present day plates.

ASSESSMENT and EVALUATION

1. Formative Assessment - completion of the two maps.
2. Summative Evaluation - written test on presented material evidence to support the theory of continental drift and the developments leading to the theory of plate tectonics.

ACCOMMODATIONS

Presenting visuals will help visual learners.

RESOURCES

Print: Hamblin, W. K. *The Earth's Dynamic System.* New York: MacMillan Pub. Company, 1989.

Montgomery, C. W. *Environmental Geology (3rd Ed.).* Dubuque, owa: Wm. C. Brown Publishers, 1992.

Vine , F. J. and Kearey, P. *Global Tectonics (2nd Ed.).* Massachusetts: Blackwell, 1996.

Wicander, R. and Monroe, J.S. *Physical Geology – Exploring the Earth.* New York: West Pub. Company, 1995.

Electronic: *Canadian Centre for Remote Sensing.* (18 April 2001). [On-Line]. Available: http://www.ccrs.nrcan.gc.ca/

Natural Resources Canada. (18 April 2001). [On-Line]. Available: http://www.nrcan.gc.ca/

Radarsat. (18 April 2001). [On-Line}. Available: http://www.rsi.ca/

Wood, C., Rowland, S. & Dorvak, J. (3 March 2000). *Introduction to Plate Tectonics: Continental Drift – Rock Sequences*. [On-Line]. Available: http://volcano.und.nodak.edu/vwdocs/vwlessons/plate_tectonics/part4.html

Activity 3B **Plate Boundaries and Mechanism for Movement**
2.4 hours (140 minutes)

DESCRIPTION

The theory of plate tectonics is based on understanding the mechanism for movement, some type of heat transfer system, convection cells. Diagrams showing the internal structure of the Earth will be used to identify the convection cells and the respective movement as a result of the heat transfer. The definitive model accounting for plate movement has not been determined although most scientists agree on a combination of three proposed models. The models differ in the areas in which the convection cells operate – the upper asthenosphere, the entire mantle and/or thermal plumes arising from the core-mantle boundary. Students will study the three types of plate boundaries and the rock associated with them.

STRAND(S) and EXPECTATIONS

STRANDS Geographic Foundations: Space and Systems
Understanding and Managing Change

SPECIFIC EXPECTATIONS

SS2.03	explain the role that convection currents are believed to play in the motion of the Earth's crustal plates
SS3.02	characterize the differences between continental and oceanic plates and demonstrate an understanding of the processes at work in the boundaries between them
UC1.01	describe the difference between human and geologic time scales
UC1.05	identify and describe the mechanisms of change within the lithosphere, atmosphere, hydrosphere, and biosphere
GI2.03	produce and interpret maps, diagrams, charts, and models

PRIOR KNOWLEDGE and SKILLS

Understanding of the internal structure of the Earth and the geologic and human time scales.

PLANNING NOTES

Prepare a diagram of the internal structure of the Earth.

TEACHING/LEARNING STRATEGIES

1. Diagrams showing the internal structure of the Earth will be used to identify the convection cells and the respective movement as a result of the heat transfer. The definitive model accounting for plate movement has not been determined although

most scientists agree on a combination of three proposed models. The models differ in the areas in which the convection cells operate – the upper asthenosphere, the entire mantle and/or thermal plumes arising from the core-mantle boundary. The video – The Birth of Theory provides a good summary of the progression from continental drift to the theory of plate tectonics (cited in Resources). It also covers the three boundaries.

2. The differing plate boundaries are the result of the way the plates move relative to one another: divergent (spreading ridge) , convergent (subduction, collision), and transform (lateral movement). The teacher will provide an explanation, diagrams, and examples for each of the boundaries. Videos of volcanic eruptions and earthquakes can be used to supplement the material presented.
3. The students will work with a rock kit – Rocks Associated with Plate Boundaries (Resources). They will complete a worksheet where they will identify the physical characteristics and determine the origin or environment for the particular rock type. The rocks included in the kit represent rocks from the three types of boundaries.

Sample: Rocks Associated with Plate Boundaries Worksheet

Rock Name	**Physical Characteristics**	**Environment or Origin**
Ophiolite Rocks: Basalt	- dark, uniformly coloured, fine-grained - breaks in chunks with sharp edges	- submarine lavas - e.g., along the Mid-Atlantic Ridge

ASSESSMENT and EVALUATION

1. Formative Assessment - complete the worksheet - Rocks Associated with Plate Boundaries.
2. Summative Evaluation - produce a model depicting one of the plate boundaries. This can be evaluated using a rubric (provided).

ACCOMMODATIONS

Any of the diagrams, models, and/or pictures can be presented using Microsoft Power Point.

RESOURCES

Rock Kit: Ward's Natural Sciences Establishment. *Rocks Associated with Plate Boundaries.* New York: Ward's Natural Sciences Establishment Inc., 1994.

Video: Magic Lantern Communications Ltd. *The Birth of a Theory*. (Available from Magic Lantern Communications Ltd., #38-775 Pacific Road, Oakville, Ontario L6L 6M4).

MODEL RUBRIC

Student's Name: ______________________ Evaluator: ______________________

Criteria	Level 1	Level 2	Level 3	Level 4	Mark
Knowledge/ Understanding • As demonstrated in features of the model	Features of the model demonstrated limited knowledge and understanding of facts, terms, concepts, and/or theories	Features of the model demonstrated some knowledge and understanding of facts, terms, concepts, and/or theories	Features of the model demonstrated considerable knowledge and understanding of facts, terms, concepts, and/or theories	Features of the model demonstrated thorough knowledge and understanding of facts, terms, concepts, and/or theories	___ 10
Communication • Through labels and other written information on the model	Labels and written information on the model has been communicated with limited clarity	Labels and written ideas on the model has been communicated with some clarity	Labels and written information on the model has been communicated with considerable clarity	Labels and written information on the model has been communicated with a high degree of clarity	___ 5
Communication • Realism of the model	The model was lacking in realism	The model was somewhat realistic	The model was realistic	The model was highly realistic	___ 5
Thinking/ Inquiry • Original (creative) or copy of an existing format?	Model was an exact copy of an existing format: very few changes have been made	Model borrowed ideas from an existing format: several original ideas have been incorporated	Model was mostly original: there was clear evidence of creative thinking	Model was highly creative, thinking skills have been employed at a very high level	___ 10
Application of Prior Knowledge and Skills	Prior knowledge skills were applied to the task with minimal effectiveness	Prior knowledge and skills were applied to the task with moderate effectiveness	Prior knowledge and skills were applied to the task in an effective manner	Prior knowledge and skills were applied to the task in a highly effective manner	___ 10
Overall Achievement Level					Mark: ___ 40

Activity 3C **<u>Physical Features – Why they are where they are</u>**
1.2 hours (70 minutes)

DESCRIPTION
Students will identity and explain the association between the three plate boundaries and the activity/activities that occurs at each boundary and why.

STRAND(S) and EXPECTATIONS

STRANDS Geographic Foundations: Space and Systems
Global Connections
Methods of Geographic Inquiry

OVERALL EXPECTATIONS

SSV.04 explain the physical processes that create landforms, climate, soils, and vegetation

GCV.01 analyze the global distribution of landforms, climate, soils, and vegetation to determine reasons for the observed distribution patterns

SPECIFIC EXPECTATIONS

SS2.04 analyze the global distribution of major physical features (e.g., Ring of Fire, mountain systems, tectonic plates) and determine reasons for the observed distribution patterns

SS3.01 interpret the spatial relationships between mountain ranges, occurrences of earthquakes, and tectonic plate boundaries and explain the processes believed to be at work

GI1.02 demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth

GI2.03 produce and interpret maps, diagrams, charts, and models

PRIOR KNOWLEDGE and SKILLS
An understanding of the three plate boundaries and the plates.

PLANNING NOTES
The maps could be computer generated. Also student's will need an atlas and previous maps (e.g., plates) to use for reference.

TEACHING/LEARNING STRATEGIES
Generate a map to identify: the plate boundaries; the mountain systems of the Earth; volcanoes (including the Ring of Fire); and earthquake activity (including the Line of Fire). Identify patterns and provide an explanation for the patterns including the type of plate boundary associated with each pattern.

ASSESSMENT and EVALUATION

Summative Evaluation - the map can be evaluated using a checklist and a rubric (provided) can be used to evaluate the explanations of the patterns.

ACCOMMODATIONS

The maps could be computer generated and the explanations could be generated using Microsoft Power Point.

RESOURCES

Print: Stanford, Q. H. *Canadian Oxford School Atlas*. Toronto: Oxford University Press, 1999.

Electronic: *Earthquake List*. (17 April 2001). [On-Line]. Available: http://geology.about.com.science/geology/cs/earthquakes/index.htm

NASA Observatorium. (18 April 2001). {on-Line]. Available: http://observe.ivv.nasa.gov/nasa/education/tools/stepby/archive.html

Volcano Related Links. (17 April 2001). [On-Line]. Available: http://geology.about.com.science/geology/cs/volcanoes/index.htm

EXPLANANTION of PATTERNS RUBRIC

Student's Name: ______________________________
Evaluator:
Teacher: ______________________
Peer: ______________________
Self: ______________________

Criteria	Level 1	Level 2	Level 3	Level 4	Mark
Knowledge/ Understanding • Processes at work	Demonstrated limited knowledge and understanding of what processes create landforms	Demonstrated some knowledge and understanding of what processes create landforms	Demonstrated considerable knowledge and understanding of what processes create landforms	Demonstrated thorough knowledge and understanding of what processes create landforms	___ 10
Thinking/ Inquiry • Analysis and reasoning	Demonstrated limited understanding and reasoning for observed landform distribution patterns	Demonstrated some understanding and reasoning for observed landform distribution patterns	Demonstrated considerable understanding and reasoning for observed landform distribution	Demonstrated a thorough understanding and reasoning for observed landform distribution	___ 10
Communication	Information was communicated with limited effectiveness	Information was communicated with some effectiveness	Information was communicated with considerable effectiveness	Information was communicated with a great degree of effectiveness	___ 10
Overall Achievement Level					Mark: ___ 30

Activity 3D | **Plate Tectonics:** | **How fast is fast?**
1.2 hours (70 minutes) | | **Where are we going?**

DESCRIPTION

The theory of plate tectonics is based on a model of the Earth where the lithosphere is broken into large parts called plates. The average rates of the plate motion are 2 to 3 cm per year. Over 100 million years that can mean a shift of 2 000 kilometres. From dating rocks of the ocean floor (180 million years old) and continents (3.96 billion years) scientists have estimated the continents have been shifting in position over the Earth's surface for over 200 million years. The Earth is dynamic and continues to evolve. Students will explore this movement.

STRAND(S) and EXPECTATIONS

STRAND Geographic Foundations: Space and Systems

SPECIFIC EXPECTATIONS

SS1.07 describe the rates at which different physical processes occur (e.g., continental erosion, soil formation, tectonic uplift)

GI1.02 demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth

PRIOR KNOWLEDGE and SKILLS

Prior use of Arc View would be an asset.

PLANNING NOTES

Arc view will need to be available on all the computers. Make sure that there are enough computers so the students can work in pairs.

TEACHING/LEARNING STRATEGIES

1. Complete the exercise called Plate Tectonics and Arc View (cited in Resources). It includes Part A: Plate Boundaries and Urban Population. In this part student's select four cities and identify the plate the city is located on and the associated plate boundary. In Part B: Plate Motion Calculator Exercise students will calculate the speed and direction at which their selected cities are moving (via plate motion).
2. Each student will explain: why the direction of movement for each city varies despite the fact the cities are on the same plate.

3. Each student will predict where each of their cities will be located in 20 000 000 years and then will complete the projection using the computer programme. Then the students will comment on their prediction versus the computer results identifying similarities and differences and providing explanations for both.

ASSESSMENT and EVALUATION

Summative Evaluation - use a rubric (provided) to evaluate the written account of the student's prediction for the location of each of their cities and the explanation for similarities and difference of their prediction versus that of the computer

ACCOMMODATIONS

If there is no access to computers and/or Arc View the following activity – Plate Tectonics and Plate Boundaries can be used. It is available from The Monograph (Resources). It looks at movement of the Pacific, Cocos, and Nazca plates.

RESOURCES

Print:

ESRI Canada. *Plate Tectonics and ArcView*. Halton District School Board Professional Development Day, December 2, 2000.

VanZant, P. "Plate Tectonics and Plate Boundaries." The *Monograph* 51 (2000): 8-10.

Electronic:

Canadian National Seisomograph Network. (18 April 2001). [On-Line]. Available: http://www.seismo.emr.ca

ESRI Canada. (21 December 2000). *Lesson Packs*. [On-Line]. Available: http://www.esricanada.com/k-12/lesson/leson_e.html

Geogratis. (18 April 2001). {On-Line]. Available: http://geogratis.cgdi.gc.ca

About the Human Internet. (19 January 2001) *Geology*. [On-Line]. Available: http://geology.com/science/geology

SUPPORTED OPINION WRITING RUBRIC

Student's Name: ______________________________
Evaluator:
Teacher: ______________________________
Peer: ______________________________
Self: ______________________________

Criteria	Level 1	Level 2	Level 3	Level 4	Mark
Logic of Predictions (Application)	Predictions lacked logic	Predictions showed some logic	Predictions showed considerable logic	Predictions showed a high degree of logic	___ / 2
Relevance and Accuracy of Information (Knowledge / Understanding)	A considerable amount of information was irrelevant and/or inaccurate	Some information was irrelevant and/or inaccurate	Most information was relevant and accurate	Information was relevant to the topic and contained accurate facts	___ / 5
Communication Skills Throughout Written Work	Written work demonstrated limited clarity	Written work demonstrated some clarity	Written work demonstrated considerable clarity	Written work demonstrated a high degree of clarity	___ / 4
Critical Thinking Skills (Thinking / Inquiry)	Critical thinking skills applied with limited effectiveness	Critical thinking skills applied in a moderately effective manner	Critical thinking skills applied in a considerably effective manner	Critical thinking skills applied in a highly effective manner	___ / 4
Overall Achievement Level					Mark: ___ /15

Activity 4A **<u>Effects of Environmental Hazards – Volcanoes and Earthquakes</u>**
3 hours (180 minutes)

DESCRIPTION

Volcanic eruptions and earthquakes occur almost daily and in many instances have no direct effect on humans but as the Earth becomes more populated the instances of direct impact have increased. Prediction of these phenomena is still imprecise and so humans have to assume the consequences (positive and negative) of living where natural disasters may occur. Students will examine human-environment interactions as a result of natural disruptions (volcanic eruptions and earthquakes).

STRAND(S) and EXPECTATIONS

STRANDS Human-Environment Interactions
Methods of Geographic Inquiry

SPECIFIC EXPECTATIONS

HE1.02	demonstrate an understanding of the trade-offs for humans living in areas subject to natural disruptions (e.g., coastal zones, slopes of active volcanoes, regions of tectonic activity such as California and Japan)
HE2.01	explain the roles of volcanoes and river estuaries in providing fertile soils for agriculture
GI1.02	demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth
GI2.03	produce and interpret maps, diagrams, charts, and models

PRIOR KNOWLEDGE and SKILLS

A thorough understanding of plate tectonics and the three plate boundaries is needed to complete the assignment. The types of volcanoes and volcanic eruptions can be reviewed at this time if they were not covered in detail in previous lessons on plate tectonics and boundaries.

PLANNING NOTES

Access to computers for research would be an asset.

TEACHING/LEARNING STRATEGIES

1. Students will chose an earthquake or volcano to research. A list of earthquakes and volcanoes can be generated by the teacher. The list could include the most recent volcanic eruptions and earthquakes or could be the most significant volcanic and earthquake events in terms of effects to the natural and human environment.

2. The assignment will include providing the following information:
   a) location of the earthquake or volcano (a map and written description);
   b) when it occurred;
   c) the effects (short-term: e.g., damage, deaths and long-term: e.g., new building codes, fertile soils, mining);
   d) earthquake - include the plates involved, the type of plate boundary, and explain the tectonic activity/events that occurred leading up to and during the event;
   e) volcano - identify the type of volcano (e.g., shield, cinder, composite) and the characteristics of that type, and identify the plate and type of plate boundary and explain the tectonic activity/events that occurred leading up to and during the event.

Note: Each student could do both an earthquake and a volcano and look at the similarities and difference regarding the plate boundaries and effects of the disruptions on the human and physical environment.

ASSESSMENT and EVALUATION

Summative Evaluation - a rubric to mark the completed assignment.

ACCOMMODATIONS

The assignment could be completed using Microsoft Power Point and include a class presentation.

RESOURCES

Print: Bolt, B. *Earthquakes: Newly Revised and Expanded.* New York: W.H. Freeman & Company, 1993.

Harris, S. L. *Agents of Chaos.* Missoula, Montana: Mountain Press Publishing Company, 1989.

National Research Council. *Assessing the Nation's Earthquakes.* Washington, D.C.: National Academy Press, 1990.

Tazieff, H. *Earthquake Predictions.* Toronto: McGraw-Hill, 1989.

Electronic: *Earthquake List.* (17 April 2001). [On-Line]. Available: http://geology.about.com.science/geology/cs/earthquakes/index.htm

On Shaky Ground: Living with Earthquakes on the North Coast. (16 October 1998). [On-Line]. Available: http://glinda.curs.humboldt.edu/earthquakes/shaky_ground.html#INFO

Seismology – Questions & Answers. (5 November 1998). [On-Line]. Available: http://www.gps.caltech.edu/~polet/QandA.html

The Ecological Monitoring and Assessment Network. (18 April 2001). [On-Line]. Available: http://www.cciw.ca/eman/

Volcano Related Links. (17 April 2001). [On-Line]. Available: http://geology.about.com.science/geology/cs/volcanoes/index.htm

Activity 4B **Your Home – the consequences of tectonic change**
2 hours (120 minutes)

DESCRIPTION
Living in Canada we are not immune to disruptions from natural hazards (e.g., flooding, landslides, earthquakes). Students will assess their own local community/region for the threat of tectonic activity and report on their findings.

STRAND(S) and EXPECTATIONS

STRANDS	Human-Environment Interactions Understanding and Managing Change Methods of Geographic Inquiry

SPECIFIC EXPECTATIONS

HE2.02	analyze the effects of environmental hazards (e.g., earthquakes, hurricanes, landslides) on human activities
UC3.06	predict both positive and negative impacts of tectonic change and climate change (e.g., earthquake risks, temperature increases) on their local community
GI1.02	demonstrate an understanding of the technology available for mapping, imaging, and measuring features and phenomena on the surface of the Earth
GI2.03	produce and interpret maps, diagrams, charts, and models

PRIOR KNOWLEDGE and SKILLS
The effects as a result of volcanic and earthquake activity would have been covered in the previous lessons.

PLANNING NOTES
Access to computers would be an asset for research and presentation of the final product.

TEACHING/LEARNING STRATEGIES
1. The student will identify the tectonic zone where they live (e.g., St. Lawrence River Valley – rift valley) and plot on a map the past earthquakes (100 years) and the Richter Scale reading or Moment Magnitude and identify any major fault zones.
2. Students will complete a report answering the following:
   a) What are the predictions regarding earthquakes in your local community/region/zone?
   b) What the Emergency Preparedness Plan for your local community (e.g., Oakville, Toronto, Southern Ontario)?

c) What are possible risks in the future?
d) What are the positive and negative impacts of tectonic activity on their local community/region?

ASSESSMENT and EVALUATION

Summative Evaluation - a map rubric and written report rubric (both provided).

ACCOMMODATIONS

This assignment could be completely done on the computer.

RESOURCES

Print: Eyles, N. (Ed.). *Environmental Geology of Urban Area – Geotext #3.* Ottawa: Geological Association Of Canada, 1997.

Eyles, N., Mohajer, A. and Rogojina, C. "Neotonic faulting in metropolitan Toronto: Implications for earthquake hazard assessment in the Lake Ontario region." *Geology* 21 (1992): 1003-1006.

Electronic: *Canadian Centre for Emergency Preparedness.* (17 April 2001). [On-Line]. Available: www.ccep.ca

On Shaky Ground: Living with Earthquakes on the North Coast. (16 October 1998). [On-Line]. Available: http://glinda.curs.humboldt.edu/earthquakes/shaky_ground.html#INFO

Seismology – Questions & Answers. (5 November 1998). [On-Line]. Available: http://www.gps.caltech.edu/~polet/QandA.html

The Southern Ontario Seismic Network. (08 November 1998). [On-Line}. Available: http://gp.uwo.ca

MAPPING RUBRIC

Student's Name: ______________________________
Map Topic: ______________________________
Evaluator:
Teacher: ______________________________
Peer: ______________________________
Self: ______________________________

Title Checklist	• Printed neatly • Located at top of page • Underline or highlighted in a box • Clearly reflects the topic				___ / 2
Legend Checklist	• Positioned in an appropriate area • Quality of construction • Accuracy of labels and symbols • Useful to the reader				___ / 2
Labels Checklist	• Printed neatly • Aligned carefully • Spelled accurately				___ / 2
Criteria	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Mark Assigned**
Directional (or North Arrow / Compass Rose)	Included: in-accurate and untidy	Included: Inaccurate, but neat	Included: accurate, but untidy	Included: accurate and neat	___ / 1
Appearance • Appropriate use of colour • Consistent shading • Use of ruler to create straight lines and/or frame (if applicable)	Ineffective use of colour, shading and/or ruler	Moderately effective use of colour, shading and/or ruler	Considerably effective use of colour, shading and/or ruler	Extremely effective use of colour, shading and/or ruler	___ / 3
Accuracy of Features Mapped	Features have been mapped with limited accuracy (more than 5 errors)	Features have been mapped with moderate accuracy (4 to 5 errors)	Features have been mapped with considerable accuracy (2 to 3 errors)	Features have been mapped with great deal of accuracy (0 to 1 error)	___ / 5
Overall Achievement Level					Mark: ___ / 15

EVALUATING QUESTION BLOCKS RUBRIC

Student's Name: ______________________________

Evaluator:

Teacher: ______________________________

Peer: ______________________________

Self: ______________________________

Criteria:	Level 1	Level 2	Level 3	Level 4	Mark
Knowledge/ Understanding	Answered with limited understanding of the local Emergency Preparedness Plan	Answered with some understanding of the local Emergency Preparedness Plan	Answered with considerable understanding of the local Emergency Preparedness Plan	Answer showed thorough understanding of the local Emergency Preparedness Plan	___ / 10
Thinking/ Inquiry • Positive and negative impacts of tectonic change	Analysis and interpretation was weak	Analysis and interpretation was satisfactory	Analysis and interpretation was sound	Analysis and interpretation was strong	___ / 10
Communication	Information has been communicated with limited effectiveness	Information has been communicated with some effectiveness	Information has been communicated with considerable effectiveness	Information has been communicated with a great degree of effectiveness	___ / 10
Application • Making predictions	Ability to make predictions was limited in effectiveness	Ability to make predictions was moderately effective	Ability to make predictions was effective	Insightful predictions were made	___ / 10
Overall Achievement Level					**Marks** ___ / 40

Activity 5 **Case Study:** **Issues related to physical geography on a local, regional, and global basis.**
3 hours (180 minutes)

DESCRIPTION

Students will identify local, regional and global issues related to physical geography and make connections (human and physical) to the material studied in this unit (e.g. the lithosphere and internal structure of the Earth). An example of a local issue would be earthquakes in Southern Ontario; regional – mining (metallic and non-metallic minerals) and the resulting contamination to water courses; and global - oil deposits and the controlling countries such as Iraq and the associated conflicts. An emphasis will be placed on identifying the connections and developing an understanding of stewardship and the need for sustainability of the environment if humans are to survive.

STRAND(S) and EXPECTATIONS

STRANDS Human-Environment Interactions
Global Connections
Methods of Geographic Inquiry

OVERALL EXPECTATIONS

HEV.04	demonstrate an understanding of importance of stewardship and sustainability as guiding principles for human use of the physical environment

SPECIFIC EXPECTATIONS

GC1.04	identify local, regional, and global issues related to physical geography
GC2.02	explain the relationships that link global patterns of landforms, climate, soils, and vegetation to each other
GC3.03	identify geopolitical issues that face nations that share various physical regions of the world (e.g., circumpolar regions, the Sahel, the Nile Valley)
GI2.03	produce and interpret maps, diagrams, charts, and models

PRIOR KNOWLEDGE and SKILLS

An understanding of stewardship and sustainability.

PLANNING NOTES

Access to computers for research would be an asset. The students could be gathering material related to local, regional and global issues throughout the unit. Newspapers and journals (Canadian Geographic, MacLean's, National Geographic) would be good sources for coverage of issues.

TEACHING/LEARNING STRATEGIES

1. The class will brainstorm local, regional and global issues and the associated connections to the unit material. Then the class will identify the commonalties of the issues (e.g., needs of the population in the area, values, what people can control versus natural forces).
2. Then each student will identify an issue either local, regional or global and what needs to be done to address the issue in order to sustain the local (regional or global) environment.

ASSESSMENT and EVALUATION

Summative Evaluation - completion of the chosen issue and a written submission (rubric provided).

ACCOMMODATIONS

Students could present their issue and plan for sustainability orally.

RESOURCES

Newspapers local, regional and national.

Magazines: Canadian Geographic
Equinox
MacLean's
National Geographic
The Internationalist
Time

Electronic: *The Ecological Monitoring and Assessment Network.* (18 April 2001). [On-Line]. Available: http://www.cciw.ca/eman/

The National Oceanic and Atmospheric Administration (USA). (18 April 2001). [On-Line]. Available: http://www.esdim.noaa.gov/

United Nations Statistics Division. (18 April 2001). [On-Line]. Available: http://www.un.org/Depts/unsd/social/index.html

RESEARCH PAPER/PROJECT RUBRIC

Student's Name: ____________________ Evaluator: ______________________

Criteria:	Level 1	Level 2	Level 3	Level 4	Mark
Knowledge/ Understanding:	Research demonstrated little understanding of relationships between key concepts	Research demonstrated some understanding of relationships between key concepts	Research demonstrated considerable understanding of relationships between key concepts	Research demonstrated thorough understanding of relationships between key concepts	__ / 10
Thinking/ Inquiry	Analysis and interpretation was weak	Analysis and interpretation was satisfactory	Analysis and interpretation was sound	Analysis and interpretation was strong	__ / 10
Communication (written):	Information has been communicated with limited effectiveness	Information has been communicated with some effectiveness	Information has been communicated with considerable effectiveness	Information has been communicated with a great degree of effectiveness	__ / 10
Communication (visual):	Inappropriate or ineffective visuals have been utilized	Appropriate visuals have been used in an ineffective manner	Appropriate visuals have been used in an effective manner	Appropriate visuals have been used in a highly effective manner	__ / 5
Application: • Making conclusions	Conclusions, were made with limited clarity and logic	Conclusions were made with some clarity and logic	Conclusions were made with considerable clarity and logic	Conclusions, were made with a high degree of clarity and logic	__ / 10
Overall Achievement Level:					**Total Mark** __ / 45

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