EARTHQUAKES HAPPEN . . .

are you ready?

An earthquake preparedness resource for Grades 8–12

Provincial Emergency Program

In using this resource, you may have suggestions to improve the resource, or you may wish to share other innovative ways of incorporating the materials into school curriculum.

The Provincial Emergency Program wants your feedback. We want to ensure the resource continues to meet the needs of BC educators, and toward this end we will review all feedback and incorporate into the original document, where possible, for future printings.

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Foreword

If you're prepared for an earthquake, you're prepared for any disaster.

Because BC is geographically located in one of Canada's most seismically active earthquake zones, it is important to give our children the awareness and knowledge they need to be prepared for the next major earthquake. The Provincial Emergency Program (PEP) of the Ministry of Public Safety and Solicitor General, in partnership with the Ministry of Education, has prepared this resource for schools to ensure that students and their families have the information they need to be as safe as possible.

Providing useful knowledge and survival tools is much more than holding a "duck, cover, hold" drill or supplying information about the causes of an earthquake—it's about encouraging youth to make emergency preparedness part of their lifestyle so they develop safe life practices that will stay with them forever.

In the past, the Provincial Emergency Program has encouraged principals, educators, and parents to promote emergency preparedness to students by suggesting school activities, providing preparedness materials and providing information about access to the PEP interactive Web site, "Kids' Zone." Our student preparedness outreach initiative is one more tool to educate young people about earthquake safety.

This project is intended to proactively educate BC students on the threat of earthquakes in BC, how to physically and emotionally prepare, how they and their families should respond, and how their community will respond to support them.

The success of the school outreach initiative depends not just on emergency management information, but on the input and involvement of educators, parents, and students. It is imperative that this initiative meet the needs of teachers and students and create a lasting awareness that could save lives.

For the Kids' Zone and additional information on emergency preparedness, visit the PEP Web site (http://www.pep.bc.ca).

Children are our future. By working together to give BC's youth the information they need to be safer in an earthquake or other disaster, and by setting a good example, we—parents, teachers, and governments—are creating a brighter future for all BC youth.

Rich Coleman
Solicitor General

BRITISH COLUMBIA
Ministry of Public Safety and Solicitor General

Christy Clark
Minister of Education

BRITISH COLUMBIA
Ministry of Education

Duck, Cover, and Hold.

Duck under a desk or table. **Cover** as much of your head and torso as possible. **Hold** on to the furniture.

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If you're prepared for an earthquake, you're prepared for any disaster.

This resource is part of a three-phase project intended to proactively educate BC students on the threat of earthquakes in the province. It is designed to prepare students physically and emotionally, teach them how they and their families should respond, and inform them how their community will respond. The objectives of **Phase 1** were to:

- identify and acquire samples of emergency/earthquake programs and learning resources in Alaska, Washington, Oregon, California, New Zealand, Quebec, and British Columbia
- interview educators and emergency planners
- evaluate collected programs and learning resources using specific technical and educational criteria
- make recommendations on learning resource development.

Research showed that there are no materials available in any of the preceding jurisdictions that:

- focus on preparing students emotionally for earthquakes
- address BC curricular requirements (e.g., in personal planning/Career and Personal Planning, social studies, science, and other subjects that deal with comparable topics)
- enable students to connect their learning and preparedness to the home and community.

The research also showed that earthquake preparedness learning resources are not widely used in BC schools, although many teachers recognize the need for them. Most of the learning resources developed in and for other jurisdictions are science-based. Emotional issues are rarely and inadequately addressed in existing learning resources. Students need resources that are engaging, interactive, relevant, and appropriate.

As a result of the research, a number of recommendations were proposed and adopted:

- the best BC curriculum match for such materials is Personal Planning K–7 and Career and Personal Planning (CAPP) 8–12; reference should also be made to other curricula (e.g., science)
- the emphasis of resources should be on building on knowledge, skills, and attitudes related to personal preparedness
- because repeat exposure to preparedness issues is the best way to ensure that young people will be able to respond in a healthy and appropriate way, resources should be developed in four clusters—grades 2–3, 5–6, 8-9, and 11–12

- resources should be in the form of teacher instructional plans that are flexible enough to allow adaptation of the materials to disasters and emergencies in general
- all relevant materials gleaned from the research should be listed in an "Annotated Resources" section of the final learning resource.

Phase 2 involved the creation of draft learning resources for both Grades K–7 and Grades 8–12. Teachers, students, parents, and school administrators were asked to review all materials. The resources were then pilot tested with students and teachers for final input before being produced and distributed.

The completion of **Phase 3** is the production and distribution of learning resource materials to BC schools in the 2002/03 school year.

Acknowledgments

This learning resource is a collaborative effort of many agencies and individuals who shared their expertise and knowledge to develop materials to help BC children become safer.

The following ministries and agencies formed the School Outreach Preparedness Project Working Group:

- Ministry of Education, former Field Services and Curriculum branches (now part of the Standards Department)
- Ministry of Finance, Risk Management Branch
- Ministry of Public Safety and Solicitor General, Provincial Emergency Program (PEP)
- GT Publishing Services Ltd.
- Points of View Research

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Introduction

"Public apathy about earthquake preparedness remains high. The consistent view of those to whom we spoke was that the public is generally apathetic about the risks of a major earthquake and is therefore not well prepared, despite the myriad of public awareness programs delivered by all levels of government and several private sector organizations."

— 1997/98 Report Earthquake Preparedness Performance Audit, Office of the Auditor General of British Columbia

Despite province-wide efforts to increase public earthquake preparedness, a study cited in the provincial audit found that 52 per cent of British Columbians said they did not have enough information on how to prepare for emergencies. Further, 62 per cent thought they did not have enough information on the natural and human-made risks in their own communities. (*Emergency Preparedness: Canadian Attitudes and Behaviour*, Environics Research Group Ltd., 1995)

While some areas of British Columbia are more susceptible to earthquakes than others, it is important to note that all of BC is considered an earthquake zone. In recent years, earthquakes have been felt in such places as Fort St. John, Dawson Creek, Nelson, and Penticton—areas not traditionally thought of as earthquake prone. About 70 per cent of the total population of BC live in the southwest, the province's most vulnerable earthquake risk area.

Since a major earthquake can occur without warning during school hours, and since schools, as a focal point of any community, play a pivotal role in supporting students, it is critical that students, teachers, administrators, and parents have the information they need to be as prepared as possible.

Many schools already practise earthquake drills. However, school-based earthquake preparedness is more than a matter of regular "duck, cover, hold" earthquake drills. Accordingly, *Earthquakes Happen …Are You Ready?* has been designed to:

- raise awareness of the earthquake hazard in British Columbia
- raise awareness about the importance of personal earthquake preparedness
- provide students and teachers with the relevant information about earthquakes

- encourage students to prepare emotionally as well as physically for the next earthquake
- help students, teachers, administrators, and parents identify potential earthquake hazards and vulnerabilities in the school, home, and community
- encourage students to turn awareness into action by applying their learning in making decisions, thinking critically, and solving problems
- provide earthquake preparedness information that can easily be adapted to many other emergency situations such as floods, severe weather, etc.

All members of the school community have a shared responsibility in maintaining safe schools.

Organization of the Resource

This resource provides the elements of a comprehensive earthquake preparedness learning resource that includes:

- **Instructional Plans** that directly address the BC curriculum. They provide teachers with procedures, resources, and student materials for two grade clusters — Grades 8-9 and Grades 11-12. The lessons address the prescribed learning outcomes for the personal planning curriculum through a study of earthquake preparedness topics.
- **Annotated Resources** of additional materials that educators, parents, and the community may find useful in addressing earthquake preparedness topics.

Using the Instructional Plans

This section of the resource contains two instructional plans for teaching earthquake preparedness in the classroom. The two instructional plans provided here are:

- Grades 8-9: Earthquake Response in the Community (page 21)
- Grades 11-12: Strategic Plans for Earthquake Response (page 51)

Each instructional plan contains instructions for delivering a unit of study related to earthquake preparedness and response. The instructional plans identify the prescribed learning outcomes addressed by the unit, suggested time, materials required, preparation, step-by-step procedural directions, suggested assessment strategies, adaptations, extensions, student handouts, assessment tools, and teacher resources.

These instructional plans are suggestions only, designed to provide guidance for teachers planning instruction to address the topic of earthquake preparedness while meeting the prescribed learning outcomes for career and personal planning 8-12. Teachers are encouraged will adapt the instructional plans to meet the needs of students and to respond to local requirements. For example, teachers may choose to:

- modify the grade 8-9 instructional plan for use at grade 10
- use the case studies from the grade 8-9 instructional plan as part of the grade 11-12 instructional plan
- adjust the instructional plans to address prescribed learning outcomes from other subject areas (see "Cross-Curricular Connections" and "Addressing Additional Curricula" later in this section for more information).

The BC curriculum for career and personal planning 8-12 has been designed to help students maintain, reinforce, and develop skills, attitudes, and behaviours that can enhance their personal well-being throughout their lives and prepare them to deal with a world of complex, ongoing change. To that end, the instructional plans included in this resource were developed to address the prescribed learning outcomes for the CAPP curriculum through a study of topics related to personal preparedness for earthquakes.

Teachers may choose to deliver the instructional plans as single, continuous units, or may wish to divide the plans into individual activities and content them over the course of several weeks. Teachers may also consider setting a specific time of year to use address earthquake preparedness as part of a school-wide approach (e.g., in September as a refresher; in May in conjunction with Emergency Preparedness week).

Cross-Curricular Connections

While it is easily possible to integrate these instructional plans with pre-existing classroom-based drills, they differ significantly from those involving simple earthquake drills, which only focus on safety procedures and evacuation.

The two instructional plans provided in this resource contain *suggestions* for ways to incorporate earthquake preparedness concepts in the classroom via the curriculum for personal planning. There are, however, many more ways that earthquake preparedness can be taught. The following two scenarios describe possible adaptations of the instructional plans to other subject areas and grades.

Scenario 1: Technology Education 10

In a school where CAPP is taught by all other subject-area teachers, a teacher decided to integrate earthquake preparedness topics in a Technology Education 10 course. The teacher chose to address the concepts through an examination of the role of technology and design in meeting the needs of consumers and society.

The class used a variety of Internet resources to research the trends and issues in technology design for earthquake safety. As a specific focus, some students chose to examine the structural modifications made to Vancouver-area infrastructures (bridges, roads, etc.) to secure the GVRD Disaster Response Route.

This integrated unit was used to help students achieve the following learning outcomes for Technology Education and Career and Personal Planning:

Technology Education, Grade 10

It is expected that students will:

- demonstrate a willingness to find unique solutions to problems that arise during the design process (Self and Society)
- demonstrate the ability to use community resources to help solve problems that come up during the design process (Self and Society)
- describe new careers and occupations in technological fields and determine their educational prerequisites (Self and Society)
- describe how societal pressures influence technological advancements and, conversely, how technological changes influence society (Self and Society)
- apply knowledge and concepts from other disciplines in solving problems that arise during the design process (Communications)
- use information-gathering and communication methods to solve problems involving technology and to create effective presentations (Communications)
- match materials to specific product requirements (Production)
- explain and use WHMIS information (Production)
- examine new trends in manufacturing processes (Production)

CAPP, Grade 10

It is expected that students will:

- assess the dangers associated with high-risk activities (Safety and Injury Prevention)
- demonstrate a knowledge of basic workplace safety regulations (Safety and Injury Prevention)
- describe the impact on the labour market of changes taking place in society, the economy, and the environment (Career Exploration)

Scenario 2: Geography 12

In a school where CAPP is taught by all other subject-area teachers, a teacher decided to integrate earthquake preparedness topics in a Geography 12 course.

Students used a variety of maps, models, and electronic resources to explore concepts of tectonic processes, and how investigating the effects of prehistoric earthquakes has helps geographers understand the nature of the physical geography of the west coast of North America. The unit concluded with a guest speaker, a seismologist who explained the use of various technologies for tracking and mapping seismic activity.

In addition to the CAPP learning outcomes addressed by the grade 11-12 instructional plan, Strategic Plans for Earthquake Response, this integrated unit was used to help students achieve the following learning outcomes for Geography 12.

Geography 12

It is expected that students will:

- explain how an understanding of geographic knowledge, skills, and attitudes can assist in daily decision making (Themes)
- identify the physical components of the atmosphere, biosphere, hydrosphere, and lithosphere (Systems)
- interpret classroom and field data by applying concepts of scale, area, distance, gradient, direction, grid references, topographic profiles, contour lines, and map symbols (Skills)
- demonstrate an ability to access, interpret, and present geographic information using topographic maps, aerial and satellite images, photographs, charts, diagrams, graphs, and tables (Skills)
- describe the application of current computer technologies to a relevant geographic issue (Skills)
- describe the features and processes associated with plate tectonics, including volcanism, earthquakes, and folding and faulting (Tectonic Processes)
- explain how various local and global landforms have resulted from tectonic processes (Tectonic Processes)
- assess the effects of tectonic processes on cultural, economic, political, and social activities (Tectonic Processes)

Addressing Additional Curricula

Some schools may wish to deliver earthquake topics as part of a school-wide, cross-curricular focus for a specified period of time. To that end, teachers may wish to consider additional ways of integrating earthquake preparedness topics in a variety of curricula:

- English—reading stories about earthquakes; writing stories, poems, etc. about earthquakes
- dance, drama, music, visual arts—creating songs, dramas, dances, or images related to earthquakes, earthquake preparedness, and the physical and emotional aftermath of earthquakes
- mathematics—simple word problems using earthquake data and scenarios (e.g., "Each person needs 4 litres of water per day. If there are 5 people in your family, how much water will you need for 3 days?")
- social studies—earthquakes throughout history and their effects on human behaviour

In addition, the Annotated Resources section of this guide includes a number of teaching and learning resources specifically related to earthquake science topics.

Addressing Sensitive Issues in the Classroom

Discussions of traumatic events such as an earthquake may give rise to a range of anxieties and fears. To help students cope with their responses, and to help ensure their emotional well being, consider the following guidelines.

- Inform students of the objectives of the curriculum in advance before addressing any sensitive issues in the classroom, and provide opportunities for them to share the information with their parents.
- Be quick to dispel students' myths about earthquakes. For example, point out that the earth does not crack and swallow people up. Most buildings do not collapse in an earthquake.
- Focus on actions students can take to help themselves.
- Assure students that fear is a normal and healthy response.
- Discussion of earthquakes and the associated emotions may trigger memories of other traumatic events. Be prepared for such responses and refer students to counsellors as required. In addition, teachers may wish to consult resources such as "When Does the Hurting Stop?" (published as part of *Responding to Critical Incidents: A Resource Guide for Schools*, Ministry of Education, 2001; available online at http://www.bced.gov.bc.ca/specialed/rci/pamph1.htm).
- Inform an administrator or counsellor when a concern arises.

The Instructional Plans

Suggested Time Allotment:
3-4 hours

Earthquake Response in the Community

Purpose/Overview

IN THIS INSTRUCTIONAL PLAN, STUDENTS ANALYSE AND DISCUSS CASE STUDIES in order to assess the earthquake risks in a number of different settings outside the home. Each case study provides focus questions for discussion, which the teacher may guide using the case study debrief teacher resource.

Prescribed Learning Outcomes

Career and Personal Planning, Grade 8

It is expected that students will:

- assess the risks associated with various unsafe situations (Safety and Injury Prevention)
- propose strategies to avoid unsafe situations (Safety and Injury Prevention)

Career and Personal Planning, Grade 9

It is expected that students will:

- explain appropriate procedures for responding to personal, school, and community emergencies (Safety and Injury Prevention)
- demonstrate basic first aid skills (Safety and Injury Prevention)

Resources

Resources

- teacher resource: "Earthquake Case Study Debrief"
- student handouts: "Earthquake Hazards are Everywhere," "An Eyewitness Account," "Understanding Earthquake Hazards"
- teacher backgrounders (on pages 59 to 77): "What Is an Earthquake?" "How Children React to Disaster," and "Emergency Supply Kit"

Preparation

To be prepared to answer students' questions, read the teacher backgrounder: What Is an Earthquake? (found later in this resource).

If you are unable to facilitate a demonstration of basic first aid skills, contact a guest for this part of the instructional plan.

Procedure

1. Begin by asking students to conduct a quickwriting exercise based on the following question: "How prepared am I to respond in an earthquake?" Allow approximately five minutes.

2. Explain to students that a large part of responding to an to an earthquake or other emergency is knowing in advance what the hazards are. Ask students to look around the classroom and brainstorm a list of all the possible earthquake hazards they can identify. When they are finished, elicit comments, recording their answers on the board. Advise students to write down any hazards they overlooked. Ask them where most of the hazards are in the classroom. Chances are most of the potential dangers will be above them. Remind them that earthquakes strike from below, but the dangers usually fall from above.

3. Ask students what they would do if an earthquake were to strike while they were in class. What do they think the earthquake would feel and sound like? How would they protect themselves? Review duck, cover, and hold procedures. Include a review of procedures for outside the class (e.g., hallway, bathroom, library, sports field).

4. Divide the class into small working groups of 3-4; then distribute copies of Part One of the case study narratives to each group. Ask students to read through the first part of their case study; then discuss the Part One questions as a group. Encourage them to take notes on their discussion.

   Hand out Part Two of the case study narratives to each group. Have them read through this part and then go over the questions at the end, again taking notes on their discussion. Repeat with Part Three. Debrief this part of the

activity by focussing specifically on the questions related to feelings. You may wish to review the teacher backgrounder: How Children React to Disaster.

5. Rearrange student groups so that new groups are comprised of members who each studied a different case study narrative. Ask students to provide a brief explanation to their group members of the case study they examined in their previous groups. Once they are finished, conduct a debrief discussion on the case studies, and what the students learned from them. You may want to refer to the teacher resource, Earthquake Case Study Debrief, for information relating to the questions asked in reference to the case studies. During the course of the discussion, you may want to ask the following:
   - What aspects of the earthquakes in the case studies surprised you?
   - How do you expect you would feel if you experienced such an earthquake?
   - What are some ways you could prepare yourself for dealing with an earthquake?
   - How do feel now, after the case studies?

   Provide time for students to use their journals to reflect on what they have learned and how they are feeling.

6. Distribute the handout: Earthquake Hazards are Everywhere. Have students work together in their new groups to complete the handout.

7. When groups are finished with the handout, go over the lists they've created as a class. Encourage them to add anything they've missed to their list. When going over the first-aid kit list, you may want to briefly review the kinds of medical supplies that are useful for treating minor injuries (e.g., bandages, antiseptic, sterile gauze pads, soap for cleaning wound, towelettes, tweezers). You may want to refer to the teacher backgrounder, Emergency Supply Kit, to share useful information on items that are helpful to have in the event of an earthquake. Remind students that it is important that they never attempt to move a person who's been seriously injured, unless that person is in obvious danger.

   Brainstorm the types of injuries that might be common in an earthquake (e.g., cuts and abrasions, broken bones, concussion, shock). Discuss and where applicable demonstrate appropriate first aid procedures for dealing with these situations.

8. Based on what they've learned, have students create their own fictional account of being caught in an earthquake. Distribute the handout: An Eyewitness Account and go over it as a class, ensuring that students understand what is involved in the assignment. Students may choose to prepare their accounts as a drama, news report, narrative, etc.

   Once students have finished their eyewitness accounts, provide opportunities for them to share with the class.

Assessment

- Have students complete a second quickwriting exercise at the end of the instructional plan (based on the same question, "How prepared am I to respond in an earthquake?"), and compare it to the first quickwriting. Have them use this as the basis for a self-assessment of what they have learned about appropriate strategies for responding to an earthquake.
- Distribute the student handout, Understanding Earthquake Hazards. Have students complete the self-assessment portion of the tool and then submit it along with their eyewitness accounts for teacher assessment. Assess their work based on the criteria outlined in the handout.

Adaptations

- If planning to use this instructional plan in an ESL classroom, take extra time to ensure that students fully understand the reading assignments. Alternatively, you may choose to read the case studies aloud, and go over them as a class. It might be preferable to have students deal with just one or two of the case study scenarios, instead of all four. You may also want to take extra time to teach any new words that are included in the case studies.
- This instructional plan can be shortened by eliminating the final activity (creating a fictional account of being caught in an earthquake).

Extensions

- Have students create a class newspaper or Web site featuring all of the different eyewitness accounts.
- Have students apply their earthquake preparedness knowledge to other emergencies or disasters that they might encounter in their lives (e.g., fire, flooding, hurricane). As a class, discuss how preparedness techniques would differ from situation to situation.
- Provide students with a number of common household items, and challenge them to identify how they can be used as emergency first aid supplies (e.g., paper towel, diaper, or sanitary napkin for a pressure bandage; magazine, ruler, or coat hanger for a splint; frozen food as a cold compress).

Case Study #1: On the Coast

Part One

Summer vacation has arrived, and the Alvaro family has set out on their long-awaited trip to the coast. They've been looking forward to it for months. They have rented a place on a secluded stretch of beach for two weeks. It's an old log cabin with a stone chimney and large bay windows looking out on to the ocean. The cabin is just up from the rocky beach, underneath a couple of huge old arbutus trees. It has one large open room, which has a kitchen on one side, a dining area in the middle, and a sitting room at the other end. There is also a bathroom and a bedroom at the end of a short hallway.

Mrs. Alvaro is looking forward to doing some fishing while they're there. She wants to catch a salmon, just like the 40 kg Chinook that's mounted on a wooden plaque hanging on the wall above the southern window. The two kids, Dom (15) and Olivia (13), are hoping to do some kayaking and windsurfing. Mr. Alvaro is just excited about the prospect of relaxing on the beach and doing some reading. He's happy to see some old hardcover books standing between the knick-knacks on the mantle above the fireplace in the main sitting room.

It's almost evening when they arrive at the cabin. Mr. and Mrs. Alvaro cook a quick meal on the kitchen's gas stove while kids set up their kayaks and windsurfing equipment beside the cabin's front door. Then they all sit down to eat dinner around the old oak table underneath the wrought-iron chandelier, which looks strangely out of place in the old log cabin.

Soon after they've finished dinner, the Alvaros get ready for bed. They've had a long day of driving, and everyone is tired. The cabin has just the one bedroom, which the parents have claimed. The two couches in the main room are both fold-out beds, so that's where Dom and Olivia will sleep. Dom takes the bed that's under the south window, while Olivia takes the one under the west window. The two kids set up a candle on the end table between the two couches so they can see their way to the bathroom, which is near the main bedroom. Just before she falls asleep, Olivia admires the way the flickering shadows dance across the large oil painting set on the wall above her bed.

Part One Questions

1. What earthquake hazards can you identify in this scene?
2. If you were Olivia or Dom, sleeping in one of the cabin's fold-out beds, what would you do if an earthquake struck?

Case Study #1: On the Coast

Part Two

At 5:30 in the morning, Dom and Olivia are awakened by a sudden loud boom. They both sit up and look at each other.

"Did you hear that?" Dom asks his sister sleepily.

Before Olivia can answer, their beds start to tremble. A few seconds later, the whole cabin is shaking.

"Earthquake!" Dom cries. "Under the table, quickly!"

He scrambles across his bed, grabs his sister's hand, and pulls her over to the oak table in the dining area. The floor is lurching so violently beneath their feet that it is difficult to keep their balance. The chandelier is swinging wildly. They make it to the table and quickly crawl under it just as the swinging chandelier misses the table and comes crashing down on the floor. The cabin is being jolted so severely that the massive table is actually jumping off the ground a few centimetres. Dom and Olivia each grab on to a leg of the table so they bounce with it and stay protected underneath it.

"Face away from the windows!" Dom tells his sister.

The room is filled with noise. The bathroom and bedroom doors are slamming loudly against the walls. Books and knick-knacks fall off the fireplace mantle and come crashing to the floor. The ground jolts violently, and both the west and south windows suddenly explode inwards, showering the beds with a spray of sharp glass. The large mounted salmon is knocked off its hook and falls heavily onto the bed Dom had been using. A moment later, the large oil painting comes banging down as well. The shaking seems to last forever. Just when Dom and Olivia think the worst must be over, the old stone chimney bursts through the cabin ceiling and breaks to pieces on the cabin floor.

As suddenly as it began, the earthquake stops. Dom and Olivia start counting to 60.

They hear their parents yelling in the bedroom. "We're okay!" Olivia shouts back, and continues counting.

After a minute, their parents come out of the bedroom, looking shaken. When they see the damage done to the living room, their jaws drop. There is no question that both of the children would have been seriously injured if they had remained in their beds during the quake.

"Thank goodness you two are okay!" their mother exclaims when she sees Dom and Olivia huddled underneath the table.

"Just stay there while we clean up all the glass," their father advises.

He goes into the kitchen area and takes a broom out of the small supply closet. He pauses for a moment. There's a faint hissing noise coming from somewhere.

"Do you hear that?" he asks his wife.

She listens carefully.

"It's gas!" she tells him. "We have to get out of here, now!"

"The candle!" Olivia says. "Where's the candle? Is it still burning?"

Amidst all the broken rock and debris it's impossible to tell.

Mr. Alvaro quickly sweeps a path through the glass and debris to the front door. His family is close behind. There's a moment of panic when the front door does not open. The kayaks and windsurfing equipment have fallen over, partially blocking the door. After some ramming and shoving, the door is opened wide enough for them to squeeze through.

"Go quickly to see if you can shut off the gas," Mrs. Alvaro tells her husband once everyone is outside. "But don't take too long! Come on you two, let's get away from the house."

The children obey their mother and moved away from the building. Dom looks up at the roof of the cabin and sees that a few large branches had snapped off the arbutus trees, and crashed against the top of the cabin. He guesses that might have led to the chimney collapse.

Olivia, meanwhile, is looking out toward the ocean. It is low tide—very low, she thinks. The water is far out. The exposed beach was dotted with moving objects. Looking more closely, she could see they were fish, flopping on the rocks.

"Hey, look at that," she says, pointing towards the beach. Dom turns to see what has caught her attention.

Part Two questions

1. How many earthquake hazards were you able to identify? Were there any you did not consider?
2. Did Dom and Olivia do what you would have done in the event of an earthquake? Is there anything you would have done differently? What would be the consequences of that action?
3. What might the low tide and exposed fish indicate? If you were near the ocean and saw the tide suddenly drop, what would you do?

Case Study #1: On the Coast

Part Three

When Dom sees the fish flopping on the rocky beach, his blood runs cold.

"Um, Mom?" he stammers. "I think we'd better get out of here, fast."

"Hmm?" his mother replies, still busy worrying about their father and the gas leak.

"Mom!" Dom points toward the ocean. "See the low tide? Those fish? We were taught in class that those were signs of a possible tsunami."

"A *tsunami*?" his mother echoes. "Oh, heavens! What next?"

"Do you mean, like a tidal wave?" Olivia asks. "Cool! I'd like to see that."

"No, you wouldn't," Dom tells her. "Come on, Mom! We have to leave now!"

The Alvaros act on Dom's advice and all pile into the car. Thankfully, Mr. Alvaro had left the keys in the ignition the night before and they're able to drive out immediately. The road away from the cabin takes them up a steep cliff, so they're out of harm's way when the tsunami hits the coast ten minutes later.

Dom was right—the low tide *was* a sign that a tsunami was approaching. The earthquake was an extremely large one, with a magnitude of 9.2. That's as big as the quake that took place off the coast of Alaska in 1964. The epicentre of the quake was about 10 km off the coast, causing a large area of ocean floor to be thrust violently upward. This generated a tsunami that grew as large as 67 metres in height in some areas. This wave caused as much damage as the quake itself. Cabins, docks, moored boats, and other structures along the coast were all destroyed by the rushing water. Damage occurred as far away as Port Alberni, BC. The area in which it was felt was about 1 300 000 km^2 (all of Alaska, parts of Canada, and south to Washington).

The Alvaros were very lucky to escape with their lives.

Part Three Questions

1. If you were involved in this earthquake, how would you feel? How would you deal with these feelings?
2. How could you help others who were feeling the same things?
3. Did you correctly identify the warning sign of the extremely low tide? If you are at sea level near the coast and an earthquake hits, what do you think is the safest course of action for you to take?

Case Study #2: Downtown

Part One

Christina has just moved to a new city. On this crisp September morning, she has taken the bus downtown to do some shopping and sightseeing in her new home.

It's a lovely day. Christina looks up to see the blue sky between the shops and tall office buildings. She notices that some buildings are very modern, with smooth marble-like walls and large windows that reflect the clouds in the sky. One modern high-rise has a suspended scaffold hanging on it. Christina guesses it must be used for window washing, although it's currently empty. Other buildings are older, and made of brick or concrete. Some of the older ones have elaborate stone facades, with moulded cornices and even a gargoyle or two glaring down at her.

It's still tourist season, so there's a lot of car and bus traffic on the street. Ahead, a bus driver is trying to get the trolleys on top of his bus reconnected to the electrical wires overhead. There are many people on the streets, going in and out of the shops. Christina weaves her way between the slower ones, pausing at the occasional window to check out a storefront display.

Part One Questions

1. How many earthquake hazards can you identify in this scene?
2. If you were in a similar urban situation and an earthquake struck, what would you do?

Case Study #2: Downtown

Part Two

Christina is admiring some chinaware in a window when she notices that the ground is trembling. It feels like a large, heavy truck is barrelling down the road right behind her. Christina glances back at to the street, and sees that all the traffic is stopped because of a red light ahead.

The trembling quickly intensifies to powerful shaking. Christina finds it difficult to remain standing—it's like being on the deck of a ship in a violent storm.

"Earthquake!" someone screams.

People begin running everywhere. Some move out into the street; others fall to the ground and crawl under parked cars.

Christina lurches as quickly as she can into a narrow doorway. The door must lead to offices or apartments above the ground floor, for there are no glass windows here. She is surrounded overhead and on both sides by concrete, with the locked metal door at her back. She starts counting to herself: one one thousand, two one thousand, three one thousand ….

She props herself against the walls of the doorway and stares out at the street in shock as the first shower of exploded window glass falls to the ground. After that she turns away from the street, fearing that some more glass might bounce up and cut her. She holds on to the handle of the door and waits for the earthquake to end. Twenty-eight one thousand, twenty-nine one thousand ….

It gets worse before it gets better. Violent shocks punctuate the quake, and make Christina feel like she's standing on top of an angry, bucking horse. She loses her balance and falls to the ground. Large booms sound as falling objects crash against the street. There are injured people moaning, frightened people screaming, car alarms going off, dogs barking, broken water mains spraying water into the street, sprinkler systems going off in the offices whose walls have fallen away, and unstable pieces of building crashing to the ground.

Finally, after 47 seconds, the shaking subsides, and it seems the earthquake is over. Christina waits another minute, then gets to her feet and turns around. She's stunned by the devastation she sees. The air is cloudy with dust. Shattered glass is everywhere. Bricks and pieces of stone are all over the street. The scaffold that was high up on the building is now lying in the middle of the road. All the cars are covered with fallen debris; some of the cars have huge dents in their roofs or shattered windshields. Sections of the road have actually cracked and been thrust upward. Across the street, jagged fragments are all that remain of several storefront displays. Some buildings have large holes in them where walls used to be. Christina can see through into the open rooms beyond, where people are shakily coming out from under desks and tables. Other buildings are missing large chunks of their roofs or stone facades. A few are actually tilting sideways or backward, as if the ground beneath them had collapsed.

"Mom!"

Christina turns at the cry and sees a boy who looks to be ten or eleven waving at a woman on the other side of the street. The woman turns and cries out in relief when she sees her son. The boy starts across the street. He's so busy looking at his mother that he doesn't notice the fallen wires on the road in front of him.

"No!" Christina yells. She grabs the boy and hauls him into her protective doorway, just before his foot touches the fallen wire.

Part Two Questions

1. Did you correctly identify all of the earthquake hazards? Were there any that surprised you?
2. What did she do correctly once the shaking had stopped?
3. What dangers should Christina be looking out for?
4. What different sights and sounds Christina is noticing right now? How would that interfere with her ability to think and act sensibly?
5. Why would Christina want to keep the boy away from the wire on the street?

Case Study #2: Downtown

Part Three

"Let me go!" the boy shrieks. "I have to get to my mom!"

Christina points to the wires on the ground.

"Do you see those?" she asks. "If you touched those, they might have electrocuted you. You could have been seriously burned!"

Just then another chunk of rock fell down on to the road, close to where the boy had been standing.

"Plus there's the danger of more debris falling off of damaged buildings," Christina said.

The boy was silent, startled by how narrowly he'd escaped danger.

"Stay there!" his mom yells from across the street. "I'll come to you as soon as we know it's safe."

Not long after, some police officers arrive on the scene. They announce with megaphones that everyone downtown is being asked to make their way north to a nearby park, where an emergency shelter is being set up. The police announce that fires have broken out in the south end of downtown, and that the entire area should be evacuated as soon as possible. The people in the street all follow after them.

At the emergency shelter, people are listening to radios reporting on the extent of the damage. Christina finds out that the earthquake was about a 6.8. That's as big as the 2001 Nisqually earthquake in Washington state, which caused over 400 injuries.

Part Three Questions

1. If you were involved in this earthquake, how would you feel? How would you deal with these feelings?
2. How could you help others who were feeling the same things?
3. Why would the fallen wire have burnt the boy?
4. What is the most dangerous threat to an urban area after an earthquake has hit? What are some ways people could work to reduce that threat?
5. If you and your family had to be evacuated to an emergency shelter, what would you do? How could you keep busy and help others? What sort of supplies would you want to have with you?
6. How prepared do you think your family would be for this type of earthquake? How would you get in touch with each other?

Case Study #3: On the Road

Part One

It's Friday afternoon, and Ravi and his father have set off on their long-awaited camping trip. Ravi was so excited about the trip that he packed all of the fishing and camping gear into the trunk of the car the night before.

After inching their way through rush-hour traffic in the city, they're finally out on the highway, heading into the mountains. The nearest town is several miles away. There are just a few cars ahead of them on the road. The one immediately in front of them is a pickup truck. It has a bunch of furniture piled up in the back. It is travelling faster than they are, and is increasing the distance between them. Up ahead, Ravi can see the road disappearing into a snowshed tunnel.

On one side of the road is a steep slope, the side of the mountain they're currently ascending. Most of the slope is dominated by tall evergreens that tower above the highway. Some areas are covered with grass and small leafy saplings. Others are bare rocky cliff. Rivulets of water trickle down the slope and disappear underneath the highway. Occasionally they cross over bridges spanning creeks and rivers.

Transformer towers are set into the mountain above them. With their electric wires, they remind Ravi of chairlifts on a ski hill.

On the other side of the road is a grassy meridian, separating the two directions of traffic. Tall poles are standing in the grass, with power lines between them.

Part One Questions

1. Can you identify the hazards in this scene?
2. If you were in a car heading up such a highway, what do you think you would notice if an earthquake struck? How would you react?
3. How would you react in the event of an earthquake if you were in this situation? Where would you most want to be?

Case Study #3: On the Road

Part Two

They round a corner and see that something strange is happening in the road ahead of them. Ravi's dad immediately slows down as they try to figure out what's going on. It looks like a large tree is down on the freeway ahead, and the cars in front of them have stopped. Ravi's first impression is that a work crew has chopped down the tree without putting the proper warning markers on the road.

The pickup truck ahead of them looks as if it's backing up, trying to put distance between itself and the tree. The truck is jerking and swaying from side-to-side, as if its wheels were coming loose. The furniture in the back is bouncing up and down. As they watch, a chair falls off the truck. It's almost as if the driver was gunning the accelerator then quickly slamming on the brakes.

Suddenly the radio in their car goes dead. Ravi and his father look at each other, puzzled.

"Do you feel that?" Ravi's father asks.

The car is shaking. Ravi had noticed it a few seconds before, but now the trembling has grown much stronger. It feels as if the tires had all suddenly gone flat.

"It's an earthquake!" he exclaims.

His dad quickly pulls the car over to the shoulder and turns off the engine. As they watch, more trees and debris fall on to the road ahead of the pickup. Ravi realizes that the quake is causing a landslide. The moving landmass knocks out one of the poles in the meridian, causing power lines to fall to the ground.

Ravi looks up at the slope that's right above their car, and sees that it's covered by a stand of tall evergreens.

"We should get out of here!" he says to his dad. "Those trees could land right on us!"

"The best thing we can do is stay right here," his father responds. "The car will protect us."

"But maybe if we go over there we'll be safer," Ravi says, pointing to the grassy meridian between the two lanes of highway.

"Trust me!" his dad says. "Keep your seatbelt on and stay in the car."

The shaking grows increasingly intense. Both Ravi and his father are jolted about violently in their seats. They watch astounded as the road in front of them begins to ripple, almost like a wave in the ocean. Portions of the road ahead crack and sink into the ground below, which seems to have turned to mush. Several more pieces of furniture fly out of the truck in front and crash on to the road. Ravi sees that the truck's wheels are actually leaving the ground, and realizes that their car is probably bouncing up and down on the road as well.

There's a sudden crash as something lands on the roof of their car. Ravi fears that a shower of heavy objects is about to rain down above them. There's another loud boom that sounds like it was just behind them.

"Dad?" Ravi says nervously.

"It's okay, we'll be all right."

Just then the shaking stops. Ravi and his father look at each other and laugh with relief.

They wait until they are sure that the quake had ceased, and then both get out of the car.

"Whoa!" Ravi shouts. "We should go check out that slide ahead to make sure that no one got hurt."

"Don't go too far from the car," his father warns. "There may be aftershocks."

Part Two Questions

1. Why did Ravi's dad think it better to remain in the car, rather than get out? What added dangers would they have exposed themselves to if they had done what Ravi suggested?
2. If you had to stop on a mountain road during an earthquake, would you rather be in a car beneath a forested slope, a grassy slope, or a rocky slope? Would you stop on a bridge? Overpass? Culvert?
3. What additional dangers might they have faced if their camping and fishing gear was piled up in the back seat, rather than locked in the trunk?

Case Study #3: On the Road

Part Three

There are a couple of large broken branches on the roof of their car. The loud bang that sounded behind them was actually a massive chunk of rock that landed on the highway some distance away. Ravi shudders to think about the damage it would have caused to their car had it landed on top of them. The rock is almost as big as the car itself.

"Wow," Ravi says. "We were lucky."

"Yeah," his father agrees. "It's a good thing we stopped here underneath all of these trees. Their roots help hold the ground together and keep it from sliding. The trees also help to slow the fall of anything that tumbles down from above, so long as it's not large enough to bring them down along with it."

"I would have thought that being underneath all these big trees would have been the most dangerous place to be," Ravi commented.

"Nope. It's grassy slopes with small trees, or the rocky cliff faces that you have to look out for. They might be places where erosion has occurred, or where landslides have already taken place. But even then the chance being hit by something is pretty small. Your chances of being injured are a whole lot higher if you're out of a car than if you're in one."

"That makes sense," Ravi admitted.

They walk up the road, to where the large landslide took place. They are careful to skirt around or jump over the deep cracks in the pavement. Some of them extended several metres deep.

As they approach, they're astonished to see that the trees, earth, and rocks have swept an entire chunk of highway down the mountainside. Other people have left their vehicles and are staring at the devastation as well. There's a group of seven or eight of them. Some come from cars that were heading in the opposite direction. A few are trying to make calls on their cell phones, but it doesn't look like they're having any luck getting through.

"Were any cars taken by the slide?" Ravi's father asks a woman who's standing there.

"No, thank goodness," she replies. "If we'd been driving just a little bit faster, though…." She shakes her head.

"The radio's back on!" yells the man who was driving the pickup.

They all listen to an emergency bulletin that says the whole area was struck by a massive earthquake. It sounds like the city was pretty badly hit. They look at each other worriedly.

"What should we do?" one man asks his wife. "We can't continue up the mountain, obviously."

They all turn around to see the large rocks and fallen tree branches that litter the highway behind them.

"Well, let's see if we can clear enough space for our cars to clear the road leading down to the mountain," Ravi's dad suggests.

They all work together to clear the road. Then they all get back in their vehicles and slowly make their way back down the mountain. They

have to stop occasionally to remove large branches or pieces of rock off the road. After driving for several kilometres, they come to a bridge that collapsed in the earthquake. They can go no further for the time being, at least.

Evening soon arrives. The sky darkens and the mountain air gets very cold. Thankfully, Ravi and dad have all of their camping gear with them (it was also a good thing they had their gear in the trunk—if it had been on the back seat, their gear would have been crashing around the interior of the car, and could have smashed into their heads or caused them other injury!). They start pulling it out of the trunk, then set up their tents in the middle of the road. A few of the other people come over to watch. One of the women is standing there, shivering. Ravi has a lot of extra clothing, so he offers her his fleece jacket. She gratefully accepts.

One of the other vehicles with them is also filled with people who were going camping. They start setting up their equipment as well. Before long they have a fire going, and food cooking on a couple of camping stoves. The campers share their blankets and extra clothing with the others. Soon everyone is sitting in a circle, sharing a meal. Bottles of water get passed around. Someone turns on a car radio so they can listen to what's happening in the city. It sounds like there's been a fair amount of damage and human injury, and some deaths. Everyone has been trying to call their friends and relatives in the city, but all the lines are busy.

Ravi's dad has a good idea. He calls Ravi's grandmother, who lives in Ontario. The long-distance line is open, and he manages to get through. She is very relieved to hear from him. She passes on the message that the rest of the family is just fine, but had been worried sick about Ravi and his dad. He tells her where they are and reassures her that they're both okay, then asks her to try and contact the RCMP to tell them that there are people stranded on the mountain highway. She promises that she won't stop trying until she gets through.

Because of all the camping gear, everyone gets through the evening just fine. Next morning, while they're fixing breakfast, a search and rescue helicopter arrives on the scene to take them all home. They find out that the earthquake registered 7.6 on the Richter scale. That's as strong as the one that hit Kobe, Japan in 1995, killing over 5000 people and causing 100 billion dollars worth of damage

Part Three Questions

1. If you were involved in this earthquake, how would you feel? How would you deal with these feelings?
2. How could you help others who were feeling the same things?
3. Earthquake preparedness experts recommend that drivers make sure their cars are equipped with emergency disaster kits, just in case a natural disaster happens when they are away from home. Based on this case study, what sort of items do you think would be good to include in such a kit?

Case Study #4: At the Mall

Part One

Cari and Hiro have gone to the local mall to buy a birthday present for their friend, Miki. She's turning fifteen on the weekend. Hiro has no idea what to get her, so Cari has agreed to help him shop.

The shopping centre is a new multilevel complex with hundreds of stores. Glass elevators carry people from level to level. There are large skylights set into the roof to keep it bright inside. Balconies and ledges on the upper levels have small trees and plants hanging over them. They give the mall a garden-like feel. Long banners hang down from the high ceiling, announcing an upcoming sidewalk sale.

The two teens explore the stores on the lower level of the mall, but nothing seems particularly appealing. They take an escalator up to the next floor, to see if they have better luck up there. Hiro decides to buy a CD in a music shop. He knows it's one that Miki has been wanting for some time.

Cari stops in a candle shop. She knows that Miki likes candles and oil lamps, and this store is filled with really cool ones. She stops in front of a shelving unit stacked with beautiful glass and ceramic oil lamps. Hiro stays with her in the shop for a few moments, then gets bored and decides to wait outside. Next door there is a pet shop. He wanders over to check out the animals in the storefront display. There are a couple large cages in the window, one filled with kittens and the other with a few small puppies. They seem to be acting strangely. Rather than sleeping or playing with each other, the animals are all huddled in a corner, trying to dig underneath each other. It looks like they're trying to hide or escape from something.

Shrugging, Hiro heads over to a nearby bench and sits down. The bench is right beside a balcony that looks down on the floor below. From here he can look down and see the food fair underneath them. He can see restaurants offering all kinds of food. He realizes that he's hungry.

Part One Questions

1. What possible earthquake hazards can you identify in this scene?
2. If you were either Cari or Hiro in this situation and an earthquake hit, what would you do?
3. If you saw animals obviously acting strangely, what would you think?

Case Study #4: At the Mall

Part Two

Cari is at the register paying for the lamp she's chosen when suddenly the floor begins to tremble. She and the store employee both look at each other.

"Do you feel that?" Cari asked.

Before the woman can answer, a sharp, violent jolt causes both of them to lose their balance, and grab on to the checkout counter. The candles and lamps in the store began shaking on the shelves, clinking against each other.

"It's an earthquake!" Cari cries.

"Quick, get behind here with me," the store worker urges her.

The floor is rolling and jerking underneath their feet. Cari clutches on to the counter and makes her way around to the other side of it. It's very difficult to walk. There's a crash as something falls off a shelf, then another.

"Quick! Get down!" the woman urges.

She and Cari both squat down behind the counter, and cover their heads and necks to make sure they're protected. The noise of objects crashing and falling all around them is deafening.

Outside the store, Hiro is sitting on the bench when he feels the first trembling. At first he thinks there must have been a large group of people running down the mall, but when he looks he sees nothing of the sort. When the shaking intensifies, he realizes it is an earthquake. He quickly scans his surroundings for a good place to protect himself. There is nothing nearby but glass storefront windows and other people running about.

Thinking quickly, Hiro drops and scrambles under the bench. It isn't the sturdiest protection, but it's better than nothing. He grabs on to the legs of the bench and watches people's feet as they ran this way and that. Many shoppers are shouting and screaming. There is a lot of other noise, too. It sounds like a lot of things are falling and breaking.

The lights in the mall flicker, then go out. There is a sudden loud shattering boom. Hiro fears the roof is falling in, and hopes that the floor he's lying on won't go crashing down to the ground level as well. One of the nearby store windows explodes, sending glass fragments skittering across the floor. Hiro brings one of his arms up to his face to protect his eyes from any glass that might come his way. He feels a sharp stinging pain in his arm.

After a period of time that seems an eternity, the shaking finally subsides. Hiro waits a few moments, then crawls out from underneath the bench. He wants to find Cari and make sure she's okay.

Part Two Questions

1. Did Cari and Hiro react in the way you might have done? What would you have done differently? What might have been the consequences of your actions?
2. What post-earthquake hazards should they be looking out for?

Case Study #4: At the Mall

Part Three

Hiro stands at the entrance of the dark candle shop and calls Cari's name. He's amazed at the devastation in the store. Most of the candles and lamps have fallen off the shelves and are now lying in pieces on the floor.

Cari and the woman who works in the store both get shakily to their feet behind the counter.

"We're okay," Cari announces, laughing with relief.

Her jaw drops when she sees what's left of the store. The woman beside her gasps.

"Come on, we should get out of here," Hiro urges them.

The two women walk cautiously through the broken glass and ceramics out of the store. They see that several nearby store windows have shattered. Hiro is relieved to see that the pet store display is still holding up okay.

"Hey, you're bleeding," Cari says, pointing to Hiro's arm.

Sure enough, a thin stream of blood is dripping from a gash in his forearm. In all the excitement, Hiro hadn't even noticed it.

"Must have been the falling glass," he commented.

"We should get that bandaged," says the woman with them.

"Here," Cari pulls a scarf from her bag and ties it around his arm. "That will do for now. You should get it properly cleaned and wrapped as quickly as possible, though. There might still be glass fragments in there."

The mall's emergency lighting system has clicked on. Hiro, Cari, and the candle store worker walk over to the balcony, to view scene below. The air is cloudy with dust, and the ground floor is covered with broken debris. Looking up, they can see that one of the ceiling skylights shattered. Parts of the roof have also collapsed, as have some of the plant-filled balconies. People are moving about, panicking.

"Where's the exit?" someone yells.

"This way!" another person answers.

A crowd of people all start moving in one direction.

"Gas! I smell gas!" someone suddenly shouts. "We've got to get out!"

The crowd of people begin pushing and yelling. Some begin to run, knocking others out of the way. Hiro and Cari look at each other.

"We should get out of here now," Cari says. She starts to walk over to the elevator that leads down to the food fair.

"Maybe we should get away from here first, and take another way down," Hiro suggests. He doesn't want to be anywhere near the food fair if there's a chance of a fire or explosion. And he knows that he should never take an elevator after an earthquake as they could easily get trapped.

They quickly make their way to the other end of the mall. Here and there they hear the odd

boom as damaged items crash to the ground. They are careful not to walk underneath anything that looks like may fall. When they get to a staircase, they descend it carefully.

"The closest exit is this way," a woman says, when they get to the ground floor. Watching their step to make sure they don't trip over any of the debris, the three of them carefully make their way to the exit, then leave the building. Once outside, they quickly head away from the building, to make sure they aren't in danger from objects falling from the outside roof and walls.

"Whoa," Hiro says when they've reached a safe place. "That's the last time I go shopping with you!"

Cari groans, then laughs. She's just happy they're all okay.

It turns out that this earthquake was the same general size and intensity the largest quake ever recorded in Canada. It registered a magnitude of 8.1. Hiro and Cari were shocked to find out that it only lasted for about a minute. It seemed to go on for much longer than that. Because it struck an urban area, the quake caused several billion dollars worth of damage, thousands of injuries, and at least 150 deaths.

Part Three Questions

1. If you were involved in this earthquake, how would you feel? How would you deal with these feelings?
2. How could you help others who were feeling the same things?
3. Why is it important to check yourself for injuries immediately following an earthquake or other emergency?
4. How can people become hazards during and after an earthquake? What is the best way to avoid the hazard of being in a crowd?

[Teacher Resource]

Earthquake Case Study Debrief

Case Study #1: "On the Coast"

Part One

1. *What earthquake hazards can you identify in this scene?*

   Answers include:

   - old stone chimney
   - large bay windows
   - proximity of log cabin to ocean
   - old large arbutus trees overhanging the cabin
   - large salmon on plaque hanging on wall
   - books, knickknacks on mantle
   - gas stove
   - kayaks, windsurfing equipment next to door
   - wrought-iron chandelier
   - position of fold-out beds right underneath large windows
   - large oil painting on wall
   - candle

2. *If you were Olivia or Dom, sleeping in one of the cabin's fold-out beds, what would you do if an earthquake struck?*

   Answer depends on student; the safest place for them to be would be underneath the solid oak dining room table. Some might mention the doorway, however there is no doorway mentioned as being close to the teenagers. The front doorway is not particularly safe as the kayak and windsurfing equipment have been propped up near it and could fall on them. They should look for an archway of an inside wall or a corner.

Part Two

1. *How many earthquake hazards were you able to identify? Were there any you did not consider?*

   Answer depends on student's identification of the hazards listed in question 1 in Part One of this case study.

2. *Did Dom and Olivia do what you would have done in the event of an earthquake? Is there anything you would have done differently? What would be the consequences of that action?*

   Answer depends on student's response to question 2 of Part One of this case study.

3. *What might the low tide and exposed fish indicate? If you were near the ocean and saw the tide suddenly drop, what would you do?*

   The low tide and exposed fish indicate that there may be a tsunami on the way, as is related in Part Three of this case study. The answers to the second part of this question will vary; the safest reaction is to get as far away from the coast as possible as quickly as possible. Point out that an extremely low tide does not always occur in advance of an earthquake.

Part Three

1. *If you were involved in this earthquake, how would you feel? How would you deal with these feelings?*

   Answer depends on student; people who survive a disaster tend to feel shocked and confused. They may later experience strong feelings of anger, panic, or apprehension. The best way to deal with those feelings is to recognize them and communicate them with others. It also helps to regain a sense of control by helping your family deal with the repercussions of the earthquake (e.g., assist with the clean-up). For more information, please see the teacher backgrounder, How Children React to Disaster.

2. *How could you help others who were feeling the same things?*

   The best way to help people deal with their emotional reactions in the aftermath of an earthquake is to acknowledge that their feelings are real and valid, and encourage them to talk about them. If there is clean-up to be done, make sure that everyone is involved in it, so they can feel like they are regaining some control over their environment.

3. *Did you correctly identify the warning sign of the extremely low tide? If you are at sea level near the coast and an earthquake hits, what do you think is the safest course of action for you to take?*

   Answers to the first question will vary; some students will know that an extremely apparently low tide can be an early indication of a tsunami, although it may also be preceded by an apparently extremely high tide. The safest thing to do if near the coast when an earthquake hits is to wait for the earthquake to end and then get as far away from the coast as possible. Tsunamis strike very quickly, and can quickly inundate a large area.

Case Study #2: Downtown

Part One

1. *How many earthquake hazards can you identify in this scene?*

   Answers could include:

   - tall office buildings
   - large windows
   - suspended scaffold
   - older buildings with elaborate stone facades
   - moulded cornices
   - gargoyles
   - cars (can block escape routes)
   - people (can panic, start trampling others trying to get to safety)
   - electrical wires
   - window storefront displays

3. *If you were in a similar urban situation and an earthquake struck, what would you do?*

   Answer depends on student; the safest thing to do would be to move away from glass windows and get to an archway of an inside wall.

Part Two

1. *Did you correctly identify all of the earthquake hazards? Were there any that surprised you?*

Answer depends on student's identification of the hazards listed in Part One.

2. *What did she do correctly once the shaking had stopped?*

   Counted to 60, moved cautiously and looked up to see if things had finished falling.

3. *What dangers should Christina be looking out for?*

   Stampeding panicked crowds, fires starting due to ruptured gas line, among other dangers.

4. *What different sights and sounds are assaulting Christina's senses right now? How would that interfere with her ability to think and act sensibly?*

   Christina is faced with a scene of devastation. There are injured people moaning, frightened people screaming, car alarms going off, dogs barking, broken water mains spraying water into the street, sprinkler systems going off in the offices whose walls have fallen away, and unstable pieces of building crashing to the ground, to name but a few of the things that are assaulting her senses. Many people in such a situation experience a feeling of intense panic or go into shock. They may not be aware of the dangers that still threaten them. Fortunately for Christine, the boy about to cross the street near the fallen electrical wire caused her to focus on the immediate and think critically about the situation.

5. *Why would Christina want to keep the boy away from the wire on the street?*

   Fallen electric wires are very dangerous as they can electrocute people who accidentally touch them.

Part Three

1. *If you were involved in this earthquake, how would you feel? How would you deal with these feelings?*

   Please see answer to question 1 in Case Study One, Part Three

2. *How could you help others who were feeling the same things?*

   Please see answer to question 2 in Case Study One, Part Three

3. *Why would the fallen wire have burnt the boy?*

   Because it is a live wire bearing a powerful electric charge.

4. *What is the most dangerous threat to an urban area after an earthquake has hit? What are some ways people could work to reduce that threat?*

   The most dangerous threat to an urban area in the aftermath of an earthquake is **fire** due to ruptured gas lines. Because of damage caused to roads and fallen debris, emergency crews often have a difficult time responding to fires after an earthquake, particular if a number of fires have broken out in different places around the city. One of the best ways to reduce the threat of fire in your own building is to clearly identify the main gas line so that if any leaks occur, people can easily locate the gas line and turn it off immediately.

5. *If you had to be evacuated to an emergency shelter, what would you do? How could you keep busy and help others? What sort of supplies would you want to have with you?*

   You could go to the people in charge of the shelter and volunteer your services. This may mean helping to distribute water or assisting family

members to find each other. If you know any first aid, you could help treat minor wounds and injuries suffered by people during the earthquake. The best supplies to have with you would be water, food, protective clothing and sensible shoes, blankets, and basic first aid materials. A batter-powered radio would also be very handy .

6. *How prepared do you think your family would be for this type of earthquake? How would you get in touch with each other?*

   Answers vary according to student. Phone lines are usually very busy after an earthquake strikes an area; it may be impossible to get through to people in the area. It is usually easier to try and contact someone who lives in a different area. You may want to point out to students that it is a good idea to establish an out-of-town contact that their family members can call in the event of an emergency in order to try and reach each other.

   For more information on family emergency planning, see the teacher backgrounder, Earthquake Preparedness.

Case Study #3: On the Road

Part One

1. *Can you identify the hazards in this scene?*

   Answers could include:

   - steep slope on one side (possibility of landslide)
   - pickup truck with furniture piled up in the back
   - areas are covered with grass and small leafy saplings (signs of an area that has suffered a relatively recent disturbance, which may be an indication that it would be more prone to experiencing another one, e.g., a landslide)
   - bare rocky cliff (rock may break away from the cliff and fall in the event of an earthquake)
   - bridges
   - transformer towers, electric wires
   - power lines strung across poles in the meridian

2. *If you were in a car heading up such a highway, what do you think you would notice if an earthquake struck? How would you react?*

   Answer depends on student. People in a car during an earthquake may notice their car wobbling, as if the tire had gone flat; the cars around them may seem to be moving strangely; they may see things falling from above, or off of the vehicles around them. They may see the road move. The safest thing to do in the event of an earthquake is to pull over to the side of the highway, stop the car, and remain inside. It's safer to be inside a car than outside a car on the road in the event of an earthquake.

3. *Where would you most want to be?*

   Answer depends on student.

Part Two

1. *Why did Ravi's dad think it better to remain in the car, rather than get out? What added dangers would they have exposed themselves to if they had done what Ravi suggested?*

Being inside a car offers a person a certain amount of protection from falling objects; being outside a car does not. If they had crossed to the meridian, they might have risked electrocution from the fallen power lines.

2. *If you had to stop on a mountain road during an earthquake, would you rather be in a car beneath a forested slope, a grassy slope, or a rocky slope? Do you think it would be a good idea to stop on a bridge, overpass or culvert?*

   Answer depends on student. The safest place to stop the car is below the open avalanche track, on the downhill side of the road, in a place where the car cannot be shaken off the road or swept off by falling trees or rocks. Other safe locations would be beneath the forested slope. While there is some danger of being injured by fallen branches, the risk of being swept away in a slide is greatly reduced. The roots of the trees help to bind the soil and hold it in place. Stopping on a bridge, overpass or culvert is not a good idea as these structures could be damaged or possibly collapse during an earthquake.

3. *What additional dangers might they have faced if their camping and fishing gear was piled up in the back seat, rather than locked in the trunk?*

   Their gear would have been crashing around the interior of the car, and could have smashed into their heads or caused them other injury.

Part Three

1. *If you were involved in this earthquake, how would you feel? How would you deal with these feelings?*

   Please see answer to question 1 in Case Study One, Part Three

2. *How could you help others who were feeling the same things?*

   Please see answer to question 2 in Case Study One, Part Three

3. *Earthquake preparedness experts recommend that drivers make sure their cars are equipped with emergency kits, just in case a natural disaster happens when they are away from home. Based on this case study, what sort of items do you think would be good to include in such a kit?*

   Please see the teacher backgrounder, Emergency Supply Kit, for more information.

Case Study #4: At the Mall

Part One

1. *What possible earthquake hazards can you identify in this scene?*

   Answers could include:

   - large skylights
   - small trees and plants hanging over balconies (can fall and injure people below)
   - long banners hanging down from the high ceiling
   - shelving unit stacked with beautiful glass and ceramic oil lamps
   - window storefront displays

2. *If you were either Cari or Hiro in this situation and an earthquake hit, what would you do?*

   Answer depends on student; For Cari, she should find protection from the glass and ceramic goods as well as whatever is over her head (e.g., fluorescent lights). The safest thing for Hiro to do is get underneath the bench he's sitting on.

3. *If you saw animals obviously acting strangely, what would you think?*

   Answer depends on student; animals have been known to exhibit strange behaviour immediately prior to an earthquake.

Part Two

1. *Did Cari and Hiro react in the way you might have done? What would you have done differently? What might have been the consequences of your actions?*

   Answer depends on the student.

2. *What post-earthquake hazards should they be looking out for?*

   Panicked crowds, falling debris, possibility of fire from ruptured gas lines (e.g., in the food fair).

Part Three

1. *If you were involved in this earthquake, how would you feel? How would you deal with these feelings?*

   Please see answer to the question 1 in Case Study One, Part Three.

2. *How could you help others who were feeling the same things?*

   Please see answer to the question 2 in Case Study One, Part Three.

3. *Why is it important to check yourself for injuries immediately following an earthquake or other emergency?*

   In the aftermath of a disaster, many survivors experience a sense of shock. They may be unaware that they have suffered wounds themselves, and suffer further harm to themselves through blood loss or overuse of injured limbs or muscles. They may become a liability to others.

4. *How can people become hazards during and after an earthquake? What is the best way to avoid the hazard of being in a crowd?*

   Some people experience a profound sense of panic in the aftermath of a disaster. In a crowded, closed environment like a shopping mall, people may feel an overwhelming need to escape as soon as possible. They may begin to rush toward the exits, mindless of those around them. In such situations, people have been known to stampede, and even step over each other in their hurry to get to a place of safety.

   The best way to avoid getting caught up in such a rush is simply to stay calm and wait, if it's possible to do so. Rather than join the crowd, seek a safe, alternate way out of the building or area. If there is no other escape route, then follow the crowd, but at a safe distance.

Earthquake Hazards are Everywhere

In your groups, work together to create the following lists:

List 1

earthquake hazards that exist in natural settings (e.g., on a mountain or near a coast)

List 2

suggestions detailing how people can best prepare themselves to deal with such hazards in the event of an earthquake

List 3

earthquake hazards that exist in highly populated urban settings (e.g., on a city street or in a shopping mall)

List 4

suggestions detailing how people best prepare themselves to deal with such hazards in the event of an earthquake

List 5

first aid items that would be useful to have to treat minor injuries that might be inflicted on someone who is caught in an earthquake (think about what type of injuries would be most common)

List 6

useful items to have in an emergency supply kit in the event of being forced to evacuate an area after an earthquake (e.g., because of threat of fire)

An Eyewitness Account

Create a fictional account from the point of view of an earthquake survivor. In your account, you should include the following:

- a detailed description of your environment (e.g., are you inside or outside? what's above and around you?)
- at least five potential earthquake hazards in the scene
- a detailed description of how the earthquake felt
- a detailed description of the sounds you heard during the earthquake
- thoughts that went through your head as the earthquake was happening
- how you protected yourself during the earthquake
- at least two hazards that were present after the earthquake had ended
- at least three items that were useful to help you deal with the aftermath of the quake (e.g., items that helped keep you comfortable outside the home in the case of evacuation, first aid items)
- three important pieces of advice on how to reduce the threat of injury or damage in the event of an earthquake
- at least one skill that would be very useful to have in the event of an earthquake
- how you felt about the experience
- how you could help others understand and be better prepared for an another earthquake.

Understanding Earthquake Hazards

Criteria: My Eyewitness Account …	Self-Assessment	Teacher Assessment
accurately identifies earthquake hazards in a number of environments		
accurately describes how an earthquake feels and sounds		
accurately identifies safe spots to be in the event of an earthquake		
demonstrates understanding of how to protect him or herself in the event of an earthquake		
accurately identifies hazards that are present even after an earthquake has ended		
accurately identifies items that would be useful to have in an emergency supply kit		
accurately identifies items that would be useful to have in a first-aid kit to treat minor injuries caused by an earthquake		
provides useful advice on what to do to reduce potential injury or damage in the event of an earthquake		
identifies at least one useful skill that would be valuable to have in the event of an earthquake		
describes feelings and makes suggestions as to how to help self and others be prepared for an earthquake		
Teacher comments:		

Rating Scale:
4 = Excellent (goes above and beyond own and teacher's expectations)
3 = Good (meets all of own and teacher's expectations)
2 = Satisfactory (meets most of own and teacher's expectations)
1 = Needs improvement (meets some of own and teacher's expectation)
0 = Incomplete/not evident (did not complete assignment)

Suggested Time Allotment:
3-5 hours

Strategic Plans for Earthquake Response

Purpose/Overview

IN THIS INSTRUCTIONAL PLAN, STUDENTS EXAMINE EARTHQUAKE PREPAREDNESS strategies in the community and workplace, and learn about how they can be more prepared for an earthquake. They consider earthquake preparedness strategies from the point of view of relevant community occupations, and have an opportunity question a panel of guest speakers representing these occupations. Finally, students research and report on a chosen earthquake related topic.

Prescribed Learning Outcomes

Career and Personal Planning, Grade 11-12

It is expected that students will:

- design, implement, assess, and evaluate a plan to promote personal, school, and community well-being (Mental Well-Being)
- demonstrate an ability to make informed choices about the prevention of injury to themselves and others (Safety and Injury Prevention)
- assess their transferable skills and relate them to occupational and lifestyle choices (Career Skills Awareness)
- apply research skills to acquire information related to job possibilities and career interests (Career Skills Awareness)

Materials and Resources

You will need:

- chart paper and pens, or chalboards and chalk

Resources

- student handouts: "Earthquake Research Topics" and "My Role in Earthquake Preparedness"
- teacher backgrounders (on pages 61 to 77): "Earthquake Preparedness," "What Is an Earthquake?" and "Earthquake Glossary"

Preparation

- Post the four focus questions for the carousel activity (see procedure step 1) on separate chalkboards or sheets of chart paper around the room. Read the teacher backgrounder: What Is an Earthquake? (found at the end of this resource).
- Be prepared to facilitate discussions on the emergency response plans of the local community and the services and resources available (see Step 6).
- Arrange for guest speakers for the panel discussion (see Step 7). Explain the focus and purpose of the discussion.

Procedure

1. Divide the class into four groups. Have each group go to one of the following four focus questions posted around the room:
   - What is the incidence of earthquakes in BC?
   - What essential services are likely to be disrupted in the event of an earthquake?
   - What secondary disasters might occur as a result of an earthquake?
   - What can you do to prepare for an earthquake?

   In their groups, students should discuss the question, and note their responses in point form on the board or chart paper. After a set amount of time (e.g., 5 minutes), signal for groups to rotate to the next focus question. As students discuss and answer the new question, they should build on the responses recorded by the previous group. Continue until all groups have answered all of the questions.

2. Bring the class back together to debrief and discuss the responses recorded. Use the information from the teacher backgrounder, What Is an Earthquake?, to fill in any gaps and dispel any myths. Sample responses may include:
   - risk of earthquakes in BC—over 800 small earthquakes in the province per year, BC is part of the Pacific "Ring of Fire" and is at a high risk of a major earthquake some time in the future, etc.

- essential services disrupted—electricity, water, gas, and sewage, telephone, television, roads, bridges, hospitals, etc.
- secondary disasters—fires, floods from broken dams, chemical spills, tsunamis, etc.
- preparing for an earthquake—participate in earthquake drills, create an emergency kit, take first aid training, develop a family emergency plan, etc.

3. Point out to students that one of the most important survival strategies for an earthquake is to remain calm, assess the situation, and determine a course of action. Therefore, it is important to plan ahead of time so that they are able to respond automatically when the time comes.

   Ask students to take a few minutes to answer the following questions in their journals:

   - What might I be able to do in an earthquake? What skills do I have that would help?
   - What emotions might I feel during and after an earthquake?

4. After students have had time to respond, ask for volunteers to share their answers. Begin by focussing on the feelings that might arise during or after an earthquake. Point out that it is natural to feel a range of feelings, including fear, in such a situation. The key is to recognize those feelings and not let them overwhelm.

5. Continue the discussion by brainstorming appropriate strategies for preparing for an earthquake. Encourage students to think of their own role in terms of helping others—younger siblings, other students, neighbours, etc. Discuss the importance of staying in contact with other family members, and following school or family protocol for emergency response (e.g., don't leave the school without someone knowing where they are going and with whom).

   Ask students to volunteer any particular skills or aptitudes they have that would be useful in responding to an emergency (e.g., ability to remain calm under pressure, first aid skills, ability to relate to young children, organizational skills). Use the teacher backgrounder, Earthquake Preparedness, to supplement students' responses. (You may wish to photocopy this backgrounder and distribute it to students.)

6. Continue the discussion by focussing on the specific needs of the local community. What local hazards are there? (e.g., chemical plants, bridges, lakes) What agencies are there locally that can respond in an emergency? (e.g., school Health and Safety committee, school peer counselling programs, local Red Cross chapter, Emergency Response Team, search and rescue, religious organizations)

   Have students select one local emergency response agency and research its role in responding to an earthquake. Discuss as a class:

- Are there any commonalities among the various agencies?
- Are there any differences? What might be the reasons for these differences
- What suggestions for improvement can we make based on what we have learned about earthquakes?
- What roles can students take in community earthquake response plans? (e.g., identifying hazards and response strategies for places frequented by youth, such as recreation centres, shopping malls, movie theatres, swimming pools)

7. Next, ask students to consider earthquake preparedness from the point of view of relevant occupations, such as civil engineer, paramedic, trauma counsellor, hospital administrator, etc. Arrange a panel of guest speakers representing these careers. Before the panel discussion, ask students to prepare questions they would like to ask about the guests' work in relation to earthquake preparedness. Remind students to include questions about the skills and training needed to perform these careers, and the challenges and rewards of these jobs.

   After the panel discussion, have students work in pairs to select one of the occupations presented and write a brief synopsis of what that person would do before, during, and after an earthquake in the local community. Have students compile their synopses in a class directory of community resources.

8. Conclude by having students work in groups or individually to research one of the subjects outlined in the student handout, Earthquake Research Topics. (Note that you may wish to assign individual topics or have students choose, depending on the resources available and the local situation). After students have completed their research, have them present their findings in an oral report, multimedia presentation, or other format. Encourage other groups to take notes. Allow time for questions and discussion.

Assessment

- Have students complete a self-assessment of their emergency preparedness at the beginning of the instructional plan, and again at the end. Use open-ended questions and statements to prompt their responses (e.g., "If an earthquake took place right now, I would ___." "Three skills I have to help me respond to an earthquake are _____." "Five important items for an emergency supply kit are _____."). Collect students' self-assessments, and look for evidence that they have incorporated learning gained. Ask them to follow up with three goals for improving their earthquake and emergency preparedness.
- Have students complete the student handout, My Role in Earthquake Preparedness. Collect their completed sheets and determine the extent to which they

were able to connect their transferable skills, knowledge, attitudes, and interests as they relate to earthquake preparedness and associated careers. Have students use their completed handouts to update their Student Learning Plans as appropriate.

- Assess students as they present their completed research projects, and collect any written work accompanying their research. Look for evidence that they are able to apply what they have learned from in-class discussions, journal writing, interviews, research, and guest speakers' responses.

Adaptations

- If planning to use this instructional plan with ESL students, take extra time to ensure that students fully understand the assignments. Have ESL students form heterogeneous reading groups for the research assignments. Use the teacher backgrounder, Earthquake Glossary, along with key visuals to introduce selected vocabulary terms related to earthquakes.
- This instructional plan can be shortened by eliminating the panel discussion and having students conduct independent research of the skills and education required for earthquake-related careers, and/or by eliminating the Earthquake Research Topics project.

Extensions

- Have students present their earthquake preparedness suggestions to the relevant community authorities.
- Have students investigate earthquake building codes in their local community. What provisions for building safety are in place?
- Explain to students that, just as schools and communities have earthquake response plans, so do most workplaces. Have students select and interview a representative of a local workplace as to their earthquake plans. (Students may choose to interview someone related to their part-time jobs, their work experience placements, or their parents' jobs). Provide an opportunity for students to share their findings. What commonalities are there among the workplace plans? What requirements are specific to particular job sites? (Note that this extension helps students address the following addition learning outcome for CAPP 11-12, Safety and Injury Prevention: follow basic workplace safety regulations)
- Challenge students to research the roles that international agencies such as the World Health Organization and the Red Cross play in responding to major earthquakes.
- Students wanting to learn more about the role they can play in preparing for and responding to an earthquake can investigate the Provincial Emergency Program volunteers program (information at http://www.pep.bc.ca/volunteer/submenu_volunteer.html).

Earthquake Research Topics

Topic 1

Research a recent disaster such as the Ontario/Quebec ice storm of 1998, the Red River flood of 1997, or the World Trade Centre terrorist attack of 2001. How did the communities in question respond? What local, provincial/state, federal, and international service agencies were involved? What can be learned from this disaster that can be applied to earthquake preparedness in BC?

Topic 2

Research your community's hazard response plans in relation to other hazards (e.g., terrorism, chemical spill). What strategies are common to earthquake preparedness?

Topic 3

If your school is located in the greater Vancouver area, research the GVRD Disaster Response Route. Where is the route and through what communities, and municipalities does it take? What criteria were used to determine this route? What needed to be done (e.g., bridge modifications) to secure the Disaster Response Route? As a starting point for your research, visit the following Web site:

http://www.th.gov.bc.ca/bchighways/disroute/1742_5.htm

Topic 4

If your school is located in a coastal region, research the risk of tsunami for your area. What measures are in place to lessen the threat of a tsunami? Does the community follow the BC Tsunami Warning and Alerting Plan? Is there a tsunami evacuation route? As a starting point for your research, visit the following Web site:

http://www.pep.bc.ca/hazard_preparedness/tsunami_preparedness.html

My Role in Earthquake Preparedness

my knowledge, skills, and aptitudes	related career or volunteer position
my interests and attitudes	**related career or volunteer position**
Career profile for one earthquake-related career: • knowledge, skills, and attitudes required • education required • education opportunities (where, how long, entrance requirements) • working conditions of this career	
I plan to become involved in my community's earthquake preparedness and response plan in the following ways:	

Teacher Backgrounders

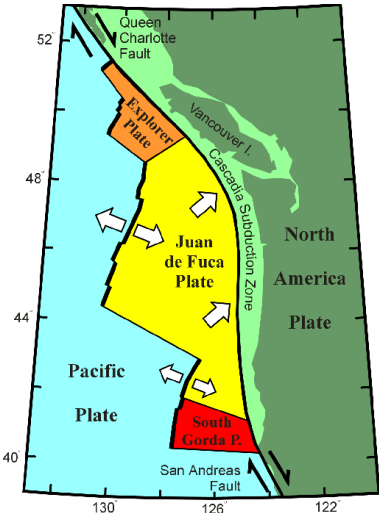
What is an Earthquake?

AN EARTHQUAKE IS A SUDDEN, SOMETIMES violent, shaking of the ground caused by the sudden release of stored energy within the Earth's crust. Earthquakes are natural events, like snowstorms or tornadoes. Although the destruction they may cause can be terrifying and devastating, they are an essential part of the geologic process that constantly shapes the surface of our planet.

What Causes Earthquakes?

Although the Earth feels solid and unmoving to us, that isn't really the case. The planet surface is actually made up of seven large, and several smaller, crustal plates moving in continual motion over the planet's molten core.

Compressional forces continually create stress on the rock within and between each of these plates. When the rock can no longer withstand this stress they suddenly break or slide creating what we feel as an earthquake.

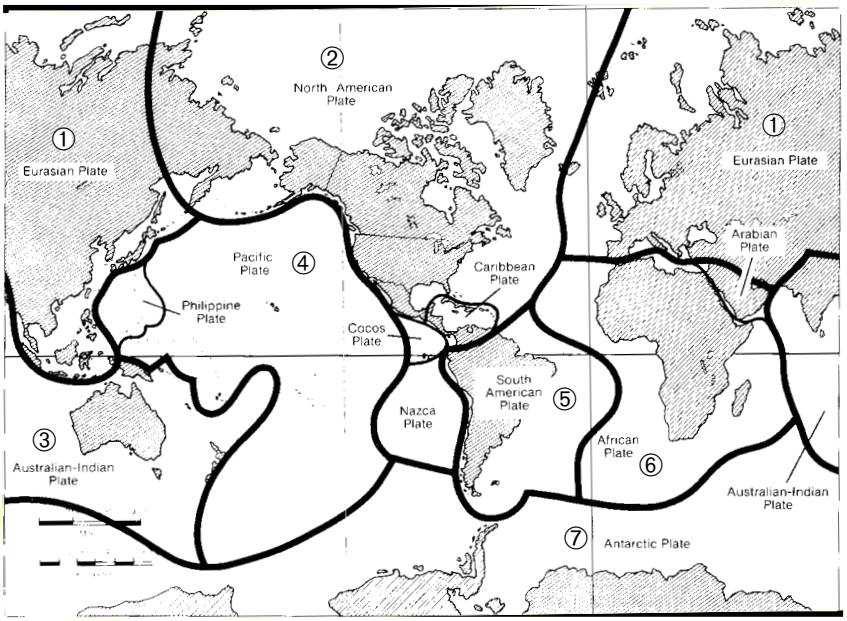


Tectonic Plates of the West Coast of Canada —National Resources Canada, Geological Survey of Canada

All of British Columbia is on the North America Plate. Note also the interaction of the Pacific Plate off the coast of BC and two smaller plates, the Juan de Fuca Plate and the Explorer Plate.

Approximately 90 per cent of the world's earthquakes occur along the margins of these tectonic plates, where one of three boundary conditions exist:

- **Divergent boundaries** occur between plates moving away from each other. Examples of a divergent boundary are seen off the west coast of Vancouver Island between the Pacific Plate and both the Juan de Fuca and Explorer Plates where an underwater mountain range is slowly being built by upwelling magma.



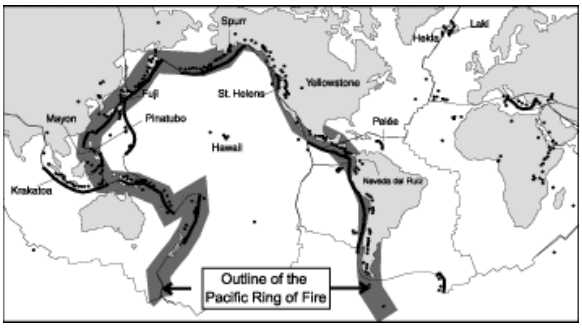
Earth's crust consists of seven major crustal plates and several minor plates. — Adapted from original by US Federal Emergency Management Agency (FEMA)

- **Transform (or Strike-Slip) boundaries** exist where tectonic plates slide horizontally past each other, neither creating nor destroying crust. Transform boundaries are commonly marked by shallow earthquakes. North of Vancouver Island, the Queen Charlotte Fault is a good example of a transform fault and is, in fact, the northern extension of the San Andreas Fault in California.
- **Convergent (or Subduction) boundaries** are boundaries where plates slowly come together and one plate is driven (or subducted) below the other. In British Columbia, the Cascadia Subduction Zone is one of the world's best examples of this type of boundary. Along this margin, the subducting Juan de Fuca and Explorer plates compress the North America Plate creating a bulge along its western margin.

Cascadia Subduction Zone (CSZ) illustrating how the Juan de Fuca Plate subducts below the North America Plate. — Natural Resources Canada

The "Pacific Ring of Fire," a band of intense earthquake activity circling the Pacific Ocean, and including Canada's west coast, is one of the most seismically active areas in the world, clearly delineating the active plate margins.

Earthquakes occur from the deformation of outer, brittle portions of these tectonic plates. Due to the heating and cooling of the rock below these plates, the resulting convection



The "Pacific Ring of Fire," shown here, is defined by the region of high earthquake activity around the margin of the Pacific Tectonic Plate. — Natural Resources Canada, Geological Survey of Canada

causes the adjacently overlying plates to move, and, under great stresses, deform. The rates of plate movements range from about 2 to 12 centimetres per year and stress can build up within deforming plates or between "locked" plate margins. If the accumulated stress exceeds the strength of the rocks, they can break suddenly, releasing the stored energy as an earthquake.

Earthquakes can take place at the surface of the Earth and at some depth within it. The *hypocentre* of an earthquake is usually somewhere between the surface and 100 km in depth, but it can occur as deep as 720 km below the surface. The *epicentre* of an earthquake is the point on the earth's surface directly above the hypocentre.

What are seismic waves?

Energy is released during an earthquake in several forms: as movement along the fault, as heat, as sound and as *seismic waves* that radiate out from the source, or hypocentre, causing the ground to shake, sometimes hundreds of kilometres away. These waves radiate from an earthquake's hypocentre in concentric spheres much like waves ripple outward from where a stone is thrown into a pond. Seismic waves are recorded and measured by sensitive scientific instruments called seismographs.

Although seismologists recognize several different types of waves, most people are interested in only two types: Primary waves (compression waves) and Secondary waves (shear waves). Within the earth, these two waves travel at different speeds and their respective speeds vary depending on a number of factors including the type and density of the material they are passing through. P waves are faster (6 to 13 kilometres per second). In comparison, S waves are slower (3.5 to 7.5 kilometres per second).

Knowing these two waves travel at different speeds is very useful. Just as light and sound travel at different speeds and we use this to gauge how far away a lightening storm is, we can gauge how far away an earthquake is by measuring the length of time between the arrival of the P and S waves. In fact, seismologists use this calculation to triangulate the location of an earthquake's hypocentre.

How are earthquakes measured?

Scientists measure two things following an earthquake: Magnitude and Intensity. Magnitude measures the amount of energy released at the hypocentre. Intensity measures the energy felt at any one particular location on the earth's surface. Therefore, while there is only one magnitude value for each earthquake, there are several intensity values recorded around the earthquake's epicentre.

Although there are several different ways of measuring magnitude (e.g., Moment Magnitude, Surface Wave Magnitude, Body Wave Magnitude, Local Magnitude), a standardized logarithmic scale (1-~10) is used to indicate the relative strength of the earthquake. Because the scale is logarithmic, each single point increase in the scale represents a tenfold increase in magnitude. So a magnitude 7.0 earthquake is 10 times greater than a magnitude 6.0.

Generally, the further you are from the hypocentre of the earthquake, the less you feel the effects of the earthquake (i.e., the intensity decreases). This is not always the case as local ground conditions can actually amplify seismic waves.

The Modified Mercalli Intensity (MMI) scale rates the effects felt on a descriptive, 12-increment scale. Intensity values are generally largest close to the epicentre of the earthquake, and will generally decrease with increasing distance from the epicentre.

Magnitude	Relative Strength	Typical Intensity (MMI) at Epicentre	No. recorded globally/year
> 8.0	Great	> IX	1
7.0 – 7.9	Major	> VIII	18
6.0 – 6.9	Strong	VII - IX	120
5.0 – 5.9	Moderate	VI – VII	800
4.0 – 4.9	Light	IV - V	6 200
3.0 – 3.9	Minor	II - III	49 000
2.0 – 2.9	Very Minor	I	365 000
1.0 – 1.9	Very Minor	I	2 920 000

Why does British Columbia experience so many earthquakes?

Because of its proximity to major plate boundaries, British Columbia alone experiences over half of Canada's earthquakes every year. The largest earthquake recorded (during historic times) in Canada was a magnitude 8.1 earthquake that struck just off BC's Queen Charlotte Islands on August 22, 1949. This earthquake ruptured a 500-km-long segment of the Queen Charlotte fault and was felt over almost all of the province, and as far north as the Yukon Territory and as far south as Oregon State.

Over 800 earthquakes occur throughout BC each year. Most of these earthquakes, though, are too small to be felt. The most seismic of these regions is off the west coast of Vancouver Island. More than 100 earthquakes with a magnitude of 5 or greater have occurred here in the past 70 years.

There are four types of earthquakes that we are exposed to in BC:

- shallow intra-plate earthquakes in the North America Plate on which all of BC is situated. These earthquakes are the result of the tremendous stress that deforms and eventually breaks rock within the western margin of this plate.

Modified Mercali Intensity Scale

Intensity	Characteristic Effects
I	Not felt by people, only detected by seismographs.
II	Felt only by a few people at rest, especially on upper floors of buildings. Delicately suspended objects may sway.
III	Felt noticeably indoors; like the vibrations due to a passing truck. Standing motor cars may rock slightly.
IV	Felt indoors by many people, outdoors by few. Dishes, windows, doors rattle. May awaken some sleepers. Standing cars rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; occasional cracked plaster; unstable objects overturned. Some disturbance of trees, poles and other tall objects.
VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; some falling plaster or damaged chimneys. Damage slight.
VII	General alarm; people run outside. Walls crack; chimneys fall. Considerable damage in poorly designed structures. Noticed by persons in moving vehicles.
VIII	Considerable damage in ordinary substantial buildings with partial collapse. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Changes in well water. Car drivers seriously disturbed.
IX	Considerable damage with partial collapse of substantial buildings. Buildings moved off foundation; ground cracks conspicuous. Underground pipes broken.
X	Ground cracks badly; landslides on river banks and steep slopes; rails bent; many buildings destroyed.
XI	Broad fissures in ground; major landslides and earth slumps; floods. Few buildings remain standing bridges destroyed; nearly all services (railways, underground pipes, cables) out of action.
XII	Total destruction. Ground rises and falls in waves; lines of sight and level distorted. Objects thrown into the air.

- shallow to deep intra-plate earthquakes off-shore in the subducting Juan de Fuca Plate—these earthquakes are the result of the stresses and deformation taking place within these oceanic crustal plates as they plunge below the North America Plate.
- shallow to deep subduction earthquakes off-shore along the Cascadia subduction fault—these earthquakes, sometimes called megathrust earthquakes, are the result of the locked subducting plate margin suddenly unlocking and the North America Plate sliding up over the subducting plates (megathrust earthquake are the world's largest earthquakes).
- shallow to deep transform or strike-slip earthquakes off the northern coast of BC.

The last Cascadia earthquake is estimated to have exceeded magnitude 9. A megathrust earthquake in Chile in 1960 was magnitude 9.5, and one in Alaska in 1964 was magnitude 9.2.

What happens in an earthquake?

You may feel little tremors, glasses and china may start to rattle, and often a low rumbling sound is associated with these tremors. The arrival of the first earthquake waves (P waves) often feels like a big truck going by. This is the time to find a safe spot, before the arrival of the S waves. The S waves and other similar waves are typically what cause most of the violent shaking. This shaking is characterized by rapid side to side shaking, as well as rolling and pitching ground, which can make it hard to walk. The amount of time between the arrival of the two types of waves depends on how close you are to the hypocentre. If the earthquake is hundreds of kilometres away, you will likely have plenty of time to find a safe place before the arrival of the S waves.

Following the initial earthquake, aftershocks occur; these are completely normal. Often, the sudden break or slip triggering the initial earthquake transfers a tremendous amount of stress to neighbouring rock. This rock then may break or slip under the new stress and may, in turn, transfer this stress further on. A sort of earthquake "chain reaction" can ensue until a new equilibrium is reached. Typically, these aftershocks are smaller than the original earthquake, but occasionally can be as large or larger than the initial earthquake. The number of aftershocks generally increases with the size of the earthquake, and may number in the tens or even hundreds.

What are the effects of earthquakes?

Most earthquakes are so mild that people barely feel them. In fact, there are about 1500 small earthquakes a year in Canada alone. However, depending on how deep the quake occurs below the surface and how forcefully the pent-up stress of the rocks is released, an earthquake can be very powerful and cause a lot of damage.

Niigata, Japan, June 16, 1964 Earthquake. Liquefaction undermines otherwise structurally sound buildings.
— Earthquake Engineering Research Center, University of California, Berkeley

When earthquake vibrations travel through soil with a high water content, the soil may take on the properties of a semi-liquid, similar to quicksand or pudding. This is called *soil liquefaction*. If the water table is near the ground surface, this tends to have the effect of liquefying the surface sediments.

Buildings, bridges, towers and other structures on ground that liquefies during an earthquake may topple over or sink into the earth. *Sand boils* or *sand volcanoes* are another common result of seismic waves moving through unconsolidated terrain. In these situations, groundwater bubbles up to the surface following the path of least resistance, carrying with it sand from below.

Rockfalls and rockslides are potential secondary impacts of earthquakes.
— Provincial Emergency Program, Government of BC

Avalanches are often triggered by winter earthquakes.
— Provincial Emergency Program, Government of BC

In addition, earthquakes can cause landslides, rockslides, or rockfalls, especially on steep slopes with soft sediment or sparse vegetation. On snow-covered slopes, an earthquake may trigger an avalanche.

When quakes occur near the coastal areas, there is also the possibility that a *tsunami* (seismic sea waves) will form. The thrusting motion of a megathrust earthquake causes large vertical movement on the sea floor and this displaces a large volume of water that travels away from the undersea motion as a tsunami. In bays or lakes, a similar, smaller phenomenon is the *seiche*, a large wave caused by water sloshing back and forth.

Damage caused by tsunami in Port Alberni, 1964. The power of a tsunami is exemplified as automobile replaces home in this central Vancouver Island community.
—Provincial Emergency Program, Government of BC

As devastating as earthquakes can be, it is important to remember that they usually last for less than a minute. The chances of being killed or injured in an earthquake are actually very low.

The greatest risks of personal or property damage during the actual shaking are due to falling items and broken glass. Several secondary effects pose substantial risk and include:

- fires—during a large-scale event, the problem of multiple simultaneous ignitions may be compounded by broken water lines
- floods—flooding may occur not only due to broken water lines, but also due to dam and dike breaches as well as tsunamis
- chemical spills—industrial spills (tankers and railcars), school chemistry labs, home chemical spills
- power supply—including downed lines and arcing transformers in the short term, and heating and power problems over the longer term
- sewer lines—health/sanitation hazard
- gas supply—fire and explosive hazard initially, heating problems over the longer term
- water supply—limits fire response capabilities and drinking water supply (potential health issues)
- phone lines—both cellular and land-based phone systems are prone to inoperability due to either infrastructure damage and/or system overload
- infrastructure damage—first responder and primary care facilities may be damaged; transportation arteries may be damaged or destroyed (e.g., bridges, roads, tunnels, ports, airports).

The more you prepare yourself for the possibility of an earthquake (e.g., by creating an emergency supply kit; having a family, school, and office emergency response plan; hazard-proofing your home, office, school), the smaller the chance of injury or damage.

Earthquake Glossary

Aftershock: Aftershocks are typically smaller earthquakes following a larger earthquake. They occur in the same general area as the larger earthquake and are the result of the transfer of stress from the larger earthquake hyopcentre to adjacent areas. Depending on a number of factors, tens or even hundreds of aftershocks may follow a single large earthquake. Generally aftershocks diminish in magnitude and frequency over time.

Cascadia Subduction Zone: The Cascadia Subduction Zone is the area off the west coast of North America in which eastward moving tectonic plates are subducting beneath the North America Plate. This zone extends from northern California to just west of northern Vancouver Island and is bounded by two transform faults—the San Andreas and the Queen Charlotte Faults.

Convergent (or Subduction) Boundary: Convergent boundaries describes a form of plate tectonic margin in which adjacent crustal plates are moving towards one another and in which one plate is forced (or subducted) beneath the other. An excellent example of such plate activity is found off the southwest coast of British Columbia in an area named the Cascadia Subduction Zone.

Crust: The earth's crust is the thin skin of rock making up the terrestrial and submarine surface of the planet. This "skin of rock," however, is not static. It is actually made up of seven major plates and several minor plates moving in constant motion over the earth's molten core.

Crustal Plate: See *Plate*.

Debris Flows: Debris flows are a form of landslide in which unconsolidated material and vegetation fail and move downslope en masse with a relatively high water content level.

Divergent (or Spreading) Boundaries: Divergent boundaries describe a form of plate tectonic margin in which adjacent crustal plates are moving away from one another. Off the southwest coast of British Columbia, the boundary between the Pacific Plate and Juan de Fuca Plate is a local example of a divergent boundary.

Earthquake: An earthquake is a sudden, sometimes violent, shaking of the ground caused by the passage of seismic waves generated cracking, faulting, and movement of rock within the earth's crust.

Earthquake Hazards: Earthquake hazards are potentially damaging, naturally occurring geomorphic events that occur as a result of an earthquake. These events include surface faulting, landslides, slumps, rockfall, avalanches, debris flows, liquefaction, sand boils, and flooding due to tsunamis or river avulsions.

Earthquake-induced Hazards: Earthquake-induced hazards are potentially damaging, non-geologic or human-made threats resulting from earthquake hazards. Examples of these hazards include chemical spills, downed power lines, fires, breached dams, broken water and sewer mains, toppled furniture and equipment, and falling lighting.

Epicentre: An earthquake's epicentre is the point on the earth's surface directly above the hypocentre of an earthquake.

Explorer Plate: The Explorer Plate is a small tectonic plate located off the west coast of Vancouver Island between the Pacific and North America Plates. Its western margin is a divergent or spreading boundary, and its eastern margin is a convergent or subducting boundary.

Hypocentre: The hypocentre of an earthquake is the point in the earth's crust at which the rock actually fails, creating the earthquake. An earthquake's hypocentre may be at the earth's surface or several tens of kilometres down.

Intensity: Intensity is a measure of ground shaking obtained through damage reports to structures and reports as to what was felt at any one location.

Juan de Fuca Plate: The Juan de Fuca Plate is a small tectonic plate off the west coast of Vancouver Island and is located between the Pacific and North America Plates. Its western margin is a divergent or spreading boundary, and its eastern margin is a convergent or subducting boundary.

Lateral Spreading: Lateral spreading describes "cracking" of the earth's surface as a result of tensional forces across the ground surface.

Landslides: A landslide is a geomorphic event in which a mass of unconsolidated sediment fails and collapses under the force of gravity.

Liquefaction: Liquefaction is a temporary process that causes soil and sand to behave like a dense fluid rather than a wet solid mass during an earthquake. It is best exemplified by the effect of standing on wet sand at low tide, moving your feet, and slowly sinking into the sand.

Magnitude: Magnitude is a measure of earthquake size and is recorded on a logarithmic (base 10) scale. Most people feel a magnitude 5.0 earthquake. The largest earthquake recorded was a magnitude 9.5 in Chile (1960).

Means of Egress: A means of egress is a continuous path of travel provided for the escape of persons from any point in a building to a safe open area outside the building with access to a public thoroughfare.

Megathrust (or Subduction) Earthquake: A megathrust earthquake is an inter-plate earthquakes resulting from failure along a subducting plate margin.

Mitigation: Mitigation referst to action taken prior to the occurrence of an earthquake to minimize losses (injury, life, property, or economic).

Modified Mercalli Intensity (MMI) Scale: The MMI scale is a globally standardised 12-point scale for assessing intensity. Expressed in roman numerals, it ranges between intensity level "I"—only felt by seismographs, to intensity level "XII"—complete destruction of structures.

Non-structural Hazard: Non-structural hazards are building contents or elements, not part of the load carrying structure, that could fail causing life or property damage.

Non-structural Mitigation: Non-structural mitigation focusses on the contents and/or elements of a building that are not part of the building structure.

North America Plate: The North America Plate is one of the seven major tectonic plates that make up the earth's crust. Extending from the west coast of North America to the middle of the Atlantic Ocean, all of British Columbia lies along the western margin of this westwardly moving plate.

Pacific Plate: The Pacific Plate is one of the seven major tectonic plates that make up the earth's crust. Underlying most of the Pacific Ocean, the northeastwardly moving Pacific Plate is forms transform boundaries with the North America Plate.

Pacific Ring of Fire: The Pacific Ring of Fire is a zone or band of intense earthquake activity that circles the Pacific Ocean. It is one of the most seismically active areas of the world and clearly delineates the active plate margins around the Pacific.

Plate (Tectonic Plate/ Crustal Plate): A techtonic or crustal plate is a large, relatively rigid segment of the earth's lithosphere that moves in relation to other plates over the earth's molten interior.

Primary Wave (P wave): P waves are the fastest moving seismic wave and propagate through a series of compressions and dilations.

Rockslide: A rockslide is geomorphic event in which a mass of rock fails and collapses under the force of gravity.

Sand Boil (or Sand Volcano): A sand boil is a localized, small-scale geomorphic feature characterized by a low (less than 1 m) mound of sand with a central vent. These features result from shaken sediments settling and the underlying ground water being forced to the surface.

Secondary Wave (S wave): S waves are the second fastest form of seismic wave and propagate with a wave form transverse to the direction of travel. S-waves do not travel through liquids.

Seiche: A seiche is an oscillations of water (standing waves) in a bay or lake.

Seismic Wave: Seismic waves are energy waves moving through the earth. They are usually generated by earthquakes or explosions and can have a number of forms: Primary waves, Secondary waves, Rayleigh waves, and Love waves.

Structural Hazard: Structural hazards are load carrying elements of a building that could be damaged or fail during or following an earthquake, causing life or property damage.

Structural Mitigation: Structural mitigation focusses on the building components that resist gravity, wind, seismic, and other loads. They include beams, columns, braces, floor and roof slabs, foundations, and load-bearing walls.

Subduction: Subduction is the geologic process in which the edge of one tectonic plate dips and descends beneath the edge of another.

Tectonic Plate: See *Plate*.

Transform (or Strike-Slip) Boundary: Transform, or strike-slip, boundaries describe a form of plate tectonic margin in which adjacent plates are sliding past one another. The San Andreas Fault is a good example of a transform boundary.

Tsunami: A tsunami is a series of abnormally large waves that can be initiated by submarine earthquakes, coastal or submarine landslides, submarine volcanic eruptions, or large meteor impacts.

How Children Respond to Disaster

Please note: While this article refers to children, many of the emotional responses may be felt by older students as well. By emphasizing communication and active listenting, you may be better able to recognize the signs of emotional distress, and help older students resolve their feelings as they arise.

A child's sense of security depends on the regularity of daily routine. When something happens to disrupt this regularity, children may suffer anxiety and fear. It is important to address these feelings and help children resolve them. How adults help children deal with their emotions in the wake of a disaster may determine how well the child will recover from the experience.

When an earthquake strikes, it is natural to experience feelings of intense distress. If you are with children, keep in mind that they will look to you for guidance and support. Your fear will be seen as proof that the danger is real. Try to put your own fear into words. By articulating your own emotions, you will encourage the children to do the same.

In the aftermath of an earthquake, a child is most afraid of:

- abandonment, being separated from her or his family
- injury or death
- another quake occurring
- being left alone.

These feelings may trouble the child long after earthquake has passed. Do not dismiss the child's fear or anxiety. These feelings are real. Even if the danger has passed, the child may still experience intense fear.

Signs of Emotional Distress

Emotional response to a disaster can take many different forms. Like adults, children may experience anger, fatigue, hyperactivity, sleeplessness, nightmares, depression, inability to concentrate, or a loss of appetite. They may develop an excessive fear of the dark, cry more often, or exhibit signs of constant worry. Look for these signals, and foster an atmosphere of open communication in which children feel free to express their fears. Remember that it may be very difficult for them to put their feelings into words. Be patient, provide opportunities for them to communicate their feelings in other ways (e.g., drawing, play-acting).

Communication

Communication is the most effective way for the children to resolve their feelings. **Listen** to what they are saying, and alleviate their fears by explaining as much as you can about the nature of the disaster. The more they know, the more reassured they will be and the better prepared to deal with the event.

Fear of Abandonment

Since one of the main fears to plague children after disaster hits is the fear of being abandoned, it is imperative that you not leave a child alone. If they are left by themselves, children will be much more likely to develop clinging behaviour that may persist for a long time.

Involving Children

One of the best ways to help children manage their feelings in the wake of an earthquake is to involve them in the recovery process as much as possible. Include them in the clean-up activities. Give them real tasks to do. This will help them combat feelings of helplessness and enable them to regain a sense of control over their own lives.

Earthquake Hazards in the Classroom

Even the safest-looking rooms may have items that in the event of an earthquake may pose a significant threat to the people within. It's a good idea to examine your classroom for possible earthquake hazards. Students can be included in this activity, so they can learn to identify potential dangers in their own homes.

Look closely around the classroom, and ask yourself these questions:

- Are all free-standing cabinets, bookcases, and shelves firmly secured to a structural support?
- Have all heavy objects been removed from upper shelves, especially those above the students' desks?
- Are all items mounted on the wall secured to prevent them from flying free or breaking windows in the event of an earthquake?
- Are seating areas located away from the windows so that students are protected from breaking glass?
- Are all hanging plants in lightweight, unbreakable pots, and fastened to closed hooks?
- If you have a television or computer in your classroom, is it securely fastened to a solid platform or securely attached to a rolling cart with wheels that lock? Are VCRs, projectors, and screens secured?
- If you have a piano in your classroom, is it secured against rolling during an earthquake?
- If you have an aquarium or other potentially hazardous display, is it located away from the seating areas?
- Are all hazardous materials (e.g., cleaning fluids, chemicals used in science experiments) firmly secured to minimize the chance of bottles breaking and leaking?
- Are light fixtures firmly fastened to the ceiling? Do hanging fixtures have safety chains?
- In the library, are student seating areas located away from book shelves?
- In the gym, is heavy equipment stored securely?
- In kitchens and science labs, are gas shut-off valves easily accessible? Are appliances connected to gas source using flexible hoses?
- Are all exits clear and unobstructed?

Earthquake Preparedness

Advance planning greatly improves the chances of survival after an earthquake or other disaster. The following are some strategies for preparing for and recovering from an earthquake.

Getting Prepared

These are some of the steps families can take to make sure that they're prepared in the event of an earthquake:

- Identify possible earthquake hazards in your home. Do what you can to reduce the threat of these hazards.
- Prepare an emergency supply kit for your family with enough food and water to last at least three days. In addition, each member of the family should have a pair of sturdy shoes and a flashlight under or near their bed.
- Hold a family meeting and create an emergency action plan. Practise this plan, and review it a few times a year so that everyone can remember what to do if an earthquake ever hits.
- Choose two meeting places for everyone to memorize:
  - one right outside your home, in case a fire breaks out
  - one outside your neighbourhood, in case it is impossible to return home (e.g., your neighbourhood has been evacuated).
- Choose an out-of-area family contact. Make sure that everyone in the family memorizes the contact's full name and phone number. When an earthquake hits, it is usually easier to make a long-distance call, as local phone lines get tied up quickly.
- Locate safe spots and danger zones in each room of your home.
- Identify safe exit routes from each room in your home.
- If you live in a house:
  - label breaker panel, gas valve, and main water valves with large, easy-to-read signs
  - ensure everyone in your family knows where and how to shut off the water, electricity, and gas supply.
- If you live in an apartment:
  - make sure everyone in your family knows where the emergency exit is (remember to use the stairs, not the elevator)
  - determine who is responsible for turning off gas mains (e.g., building manager)
  - show them where the fire alarm is, and explain when and how to use it.
- Make sure appliances and shelves are firmly fastened to the wallsor floor, and that gas servicing to appliances uses flexible hoses. Place large or heavy objects on lower shelves. Brace high and top-heavy objects. Store bottled foods, glass, china, and other breakables on low shelves or in cabinets that can fasten shut.
- Know where and how to shut off all utilities, and keep a wrench handy to shut off valves.
- Take a first aid course.

When the Ground Moves

It's important to take quick action to be safe when the ground first starts to shake. Don't wait until you're certain an earthquake is actually occurring.

- **Duck, cover, and hold**. At the first sign of ground shaking, duck under a desk or table, cover head and torso, and hold on to the legs of the table or desk. It is very important to make sure your head and neck are protected. If a desk is not available, sit on the floor with your back toward an inside wall, knees up to your chest, elbows on your knees, and hands over your head. Alternatively, adopt the same posture in an archway or doorway (if a doorway, prop a book in the door to keep it from swinging). Make sure you're away from windows and outside walls.
- Stay away from the kitchen. The kitchen is the highest hazard area in the home. There may be moving appliances and flying dishes. There may be gas or water pipes leaking. This may lead to fire or flooding.
- In a high-rise building: Stay in the building on the same floor. An evacuation may not be necessary. Do not use elevators.
- If outdoors: Stay there unless it is unsafe. Move away from buildings, trees, streetlights, and utility wires.
- If you are in a vehicle, pull over to the side of the road (to keep the road clear for emergency vehicles), and stop as quickly as safety permits. Stay in the vehicle. Avoid bridges, overpasses, tunnels, and underpasses; avoid stopping near or under buildings, trees, or utility wires.

When the Shaking Stops

- Remain calm, assess the situation, and determine a course of action.
- Stay in your safe place, and count to 60. When you move from your safe place, move cautiously, looking up and around for potential hazards.
- Check yourself and those around you for injuries.
- If you live near coastal waters, be aware that the earthquake may have caused a tsunami. Evacuate to higher ground immediately and stay there until you are told it is safe to return.
- If the electricity is out, use flashlights or battery-powered lanterns. Do **not** use candles, matches, or open flames indoors because of the possibility of gas leaks. Likewise, flashlights should be "intrinsically safe" (sparkless).
- If you smell gas or hear a hissing or blowing sound, open a window and leave the building immediately and call the gas company. If possible, shut off the main gas valve outside.
- If there is electrical damage, switch off the power at the main control panel.
- If water pipes are damaged, shut off the water supply at the main valve.
- Wear sturdy shoes in areas covered with fallen debris and broken glass.
- Check your home for structural damage.
- Clean up spilled medicines, bleaches, gasoline, and other flammable liquids.
- Do not flush toilets until you know that sewage lines have not been damaged.
- Open cabinets cautiously. Beware of objects that can fall off shelves.
- Use the phone (including cell phones) only to report a life-threatening emergency. Hang up phones that were shaken off their hooks to keep the lines clear.
- Listen to news reports for the latest emergency information.
- Stay away from damaged areas, unless the relevant authorities have specifically requested your assistance.
- Earthquakes are usually followed by smaller tremors, or aftershocks. Be prepared for these.

Emergency Supply Kit

One of the best things your family can do to prepare for an earthquake is put together an emergency supply kit and store it in an easily accessible place in your home. Your kit should include the items your family will most likely need in the event of an evacuation. These should be stored in an easy-to-carry container such as a large covered plastic garbage pail, a backpack, or a duffel bag. It's also a good idea to keep a smaller emergency kit in the family vehicle and at your workplace.

If you have infants, disabled members of the household, and/or pets, you will also need to include any special supplies and equipment they will need.

Water

Store four litres of water per person per day, and have a minimum three-day supply on hand. In addition, include purifying agents in your kit, such as iodine tablets, bleach, etc.

Store your water in thoroughly washed plastic, fibreglass, or enamel-lined metal containers. Never use a container that has held toxic substances! Plastic containers, such as soft drink bottles or bulk water containers, are the best. You can also purchase food-grade plastic buckets or drums. Make sure to change your water every few months, so that it stays fresh.

Food

Store at least a three-day supply of non-perishable food for each person. Choose items that require no refrigeration, cooking, or preparation. Select food items that are compact and easy to carry. Be sure to rotate the food supply every six months to keep it fresh.

- ready-to-eat canned meats, fruits and vegetables
- soups—bouillon cubes or dried soups in a cup
- milk—powdered or canned
- stress foods—sugar cookies, hard candy
- juices—canned, crystallized, or juice boxes
- protein foods such as smoked or dried meats, beef jerky, or soy jerky
- high-energy foods—peanut butter, nuts, trail mix, etc.

First Aid Kit

- sterile adhesive bandages in assorted shapes and sizes
- sterile gauze pads, rolls
- adhesive tape
- tensor bandages
- scissors, tweezers, needle, safety razor blade, medicine dropper
- bar of soap
- moistened towelettes
- antiseptic
- non-breakable thermometer
- petroleum jelly or other lubricant
- assorted sizes of safety pins
- latex or rubber gloves
- eye wash
- pain relievers
- antacid
- vitamins

- laxative
- anti-diarrhea medication
- activated charcoal (to absorb poisons)
- emetic (to induce vomiting)

Tools and Miscellaneous Supplies

- sturdy shoes and at least one complete change of clothes for each family member
- flashlight and extra batteries (flashlight should be "intrinsically safe" or sparkless)
- battery-operated radio and extra batteries
- cash or traveller's cheques (including small change)
- fire extinguisher, small canister, ABC type
- pliers, screwdriver, shut-off wrench for gas and water
- compass
- aluminum foil
- signal flare
- needles, thread
- cups, plates, and utensils (plastic is lightest)
- manual can opener, utility knife
- tent or tarp, plastic sheeting
- bedding (sleeping bags, blankets, etc.)
- tape, rope
- matches in a waterproof container
- paper, pencil
- whistle
- dust mask and work gloves

Special Items

- baby supplies (formula, powdered milk, bottles, diapers)
- prescription drugs (e.g., heart and high blood pressure medications, insulin)
- contact lenses and supplies, extra prescription eyeglasses
- feminine sanitary supplies
- personal toiletries (toothbrush, tooth-paste, etc.)
- entertainment (books, games, toys, etc. for both children and adults)

Important Family Documents

Keep copies of these in a waterproof, fireproof portable container:

- will, insurance policies, contracts, deeds, stocks, and bonds
- family records (birth, marriage, death certificates)
- passports, social insurance cards, immunization records
- bank account numbers, credit card account numbers and companies
- inventory of valuable household goods, important telephone numbers

Annotated Resources

Instructional-Based Resources

Title	Source	Date	Grade	Comments
Emergency!	*Office of Critical Infrastructure Protection and Emergency Preparedness (formerly Emergency Preparedness Canada)*	*1990*	**7-10**	• *preparedness and response for a variety of emergencies* • *video + teacher's manual with lesson plans, teacher background, resource list* • *also available in French*
Be Ready to Be Safe	*Canadian Red Cross*	*1997*	**8-10**	• *natural disaster preparedness and response in general — very little specific to earthquakes* • *multimedia: facilitator's guide (lesson plan based), student guide (background information and exercises), video* • *also available in French*
Masters of Disaster	*American Red Cross*	*2000*	**K-8**	• *three separate resources for three grade clusters (K-2, 3-5, and 6-8)* • *general emergency preparedness, hurricanes, floods, tornados, lightning, earthquakes* • *multimedia: lesson plans, with handouts, stickers, posters, video, printable paper, CD-ROM* • *emphasis on science, some PP content*
Seismic Sleuths	*Federal Emergency Management Agency (FEMA)*	*1992*	**7-12**	• *what causes earthquakes, seismology, preparedness and response* • *comprehensive lesson plans* • *emphasizes science connection* • *more appropriate for 10-12 than 7-9*
Oregon Earthquake and Tsunami Curriculum	*Oregon Department of Geology and Mineral Industries*	*1998*	**K-10**	• *three separate resources for three grade clusters (K-3, 4-6, and 7-10)* • *lesson plan based, including some handouts, teacher background; also includes resource lists and school procedures* • *science, math, and PP/CAPP connections*

Policies and Procedures

Title	Source	Date	Comments
School Earthquake Safety Guidebook	*BC Ministry of Education*	**1989**	• *guidelines for school/district earthquake preparedness and response plans* • *available online at http://www.pep.bc.ca/hazard_preparedness/earthquake_preparedness.html*
Responding to Critical Incidents: A Resource Guide for Schools	*BC Ministry of Education*	**2001**	• *designed to assist schools in developing protocol for responding to "critical incidents"; principles can easily be applied to earthquakes and other natural disasters* • *available online at http://www.bced.gov.bc.ca/specialed/rci/welcome.htm*
Emergency Preparedness Program	*School District 43 (Coquitlam)*	**2001**	• *emergency preparedness and response* • *procedures manual* • *available online at http://www.sd43.bc.ca/newsd43/general%5Finfo/publications/emergency%5Fprep%5Fprogram/eppmanual.htm*
Emergency Management for North Shore Schools	*School District 44 and 45 (North and West Vancouver)*	**2000**	• *emergency preparedness and response* • *collection of information sheets on "emergency preparedness planning"*
Guidebook for Developing a School Earthquake Safety Program	*FEMA*	**1990**	• *developing a school/district earthquake procedure* • *procedures manual* • *also available online at http://www.fema.gov/mit/schfac.htm*
Seismic Considerations—Elementary and Secondary Schools	*FEMA*	**1990**	• *earthquake-proofing school buildings — both at design stage and via retrofitting*
Los Angeles Unified School District policy package	*Los Angeles Unified School District*	**unknown**	• *comprehensive policy and procedures for emergencies/disasters (including bomb threats, shootings, riots, etc. as well as earthquakes)* • *video, training materials, procedures manual*
Arkansas School Earthquake Preparedness Guidebook	*State of Arkansas*	**1993**	• *emergency preparedness and response* • *procedures manual* • *full text available online at http://quake.ualr.edu/schools/guide/*
Claremont Unified School District Emergency Preparedness Plan	*State of California*	**1998**	• *emergency preparedness and response* • *procedures manual* • *full text available online at http://www.cusd.claremont.edu/par/epp/index.html*

Resources for Parents, Families, and the Community

Title	Source	Date	Comments
Prepare Now for an Earthquake in BC	*Inter-Agency Emergency Preparedness Council*	**unknown**	• *earthquake preparedness and response* • *focus on home and family* • *also available online at http://www.pep.bc.ca/hazard_preparedness/prepare_now/prepare.html*
Earthquake Survival Guide	*Ministry of Public Safety and Solicitor General*	**1998**	• *earthquake preparedness and response-- "pocket-sized" guide* • *also available online at http://www.pep.bc.ca/hazard_preparedness/earthquake_preparedness.html*
Quakesafe	*Canadian Red Cross*	**1994**	• *earthquake preparedness and response at home* • *for parents, with suggested discussion points for children* • *video (8:30)*
Be Prepared Not Scared	*Canadian Red Cross*	**1999**	• *general, yet comprehensive, advice aimed at families/adults for preparing for an emergency* • *pamphlet* • *joint production of Emergency Preparedness Canada, Home Depot, and the Red Cross* • *full version also available online at http://www.epc-pcc.gc.ca/publicinfo/self_help_ad/self_help/self_bepre.html*
Earthquake: Being Prepared at Home and School	*Neal Goldin Productions*	**1991**	• *what happens in an earthquake; earthquake preparedness and response* • *video (11:30)* • *formerly a provincially "recommended" video for PP K-7*
On Shaky Ground	*BCTV*	**1996**	• *what happens during/after an earthquake; strategies for coping* • *video (47:27)* • *done in the format of a simulated news broadcast after a 7.5 has hit Vancouver — "live" pictures of various rescue/aftermath scenarios, plus interviews with emergency response personnel*
Shake Down: Now is the Time to Get Prepared	*BC Gas*	**2001**	• *earthquake-proofing in relation to natural gas* • *online resource — available at http://www.bcgas.com/home/eme_after.html*

Resources for Parents, Families, and the Community (cont'd)

Title	Source	Date	Comments
Earthquake ABC: A Child's View of Earthquake Facts and Feelings	*Sirius Productions*	**1994**	• *children's feelings about earthquakes* • *alphabet book (e.g., A is for Aftershock) with pictures and text by children, teacher guide, and parent guide* • *available online at http://home.earthlink.net/~torg/*
Be Ready 1-2-3	*American Red Cross*	**1991**	• *emergency preparedness and response, specifically fires, storms, and earthquakes* • *facilitator's guide (lesson plan based), student guide (the Be Ready Book) for children approximately 5-10 yrs old* • *designed to be taught by any "instructor," not just classroom teachers (e.g., parents, high school students)* • *available online at http://www.redcross.org/pubs/dspubs/tchrschl.html* • *also available (online) in Spanish and Vietnamese*
Disaster Preparedness Coloring Book	*American Red Cross*	**1993**	• *general emergency preparedness, plus specific info for earthquakes, tornados, fire, thunderstorms, etc.* • *designed to be worked on with children and parents together (e.g., includes discussion points for parents)*

Web Sites

Title	Comments
Provincial Emergency Program (PEP)	• *http://www.pep.bc.ca/* • *BC-specific* • *includes:* – *specific information related to earthquakes (earthquake preparedness and response; seismology info)-- http://www.pep.bc.ca/hazard_preparedness/earthquake_preparedness.html* – *specific information related to tsunami http://www.pep.bc.ca/hazard_preparedness/tsunami_preparedness.html* – *kids zone http://www.pep.bc.ca/kids/submenu_kids.html*
Federal Emergency Management Agency (FEMA)	• *http://www.fema.gov/* • *general disaster preparedness and response* • *many resources available online free for downloading, including:* – *Helping Children Cope with Disaster* – *Your Family Disaster Plan* – *Emergency Food and Water Supplies* – *Coping With Stress Caused by Natural Disasters* • *includes "FEMA for Kids"--activities and resources for children, plus parent and educator support (http://www.fema.gov/kids/)*
Office of Critical Infrastructure Protection and Emergency Preparedness *(formerly Emergency Preparedness Canada)*	• *http://www.ocipep-bpiepc.gc.ca* • *various resources and fact sheets on emergency preparedness, what the federal government does in emergencies*
Canadian Red Cross	• *http://www.redcross.ca/index_english.html* • *overview of what the Canadian Red Cross does; contact information for local chapters*
American Red Cross	• *http://www.redcross.org* • *information about the services they provide* • *some resources available online*

Contact Information

PEP—Provincial Emergency Program
455 Boleskine Road
Victoria, BC V8Z 1E7
Tel: (250) 952-4913
Fax: (250) 952-4888
(Mailing Address: PO Box 9201 Stn Prov Govt, Victoria, V8W 9J1)
www.pep.bc.ca
PEP also has 6 regional offices—check the web site for details.

Justice Institute of BC (JIBC)
The Justice Institute does not publish any of the resources cited here, but does have many of materials available through its library. Resources may be borrowed directly or through an inter-library loan via your public or school library.

715 McBride Boulevard
New Westminster, BC V3L 5T4
Phone: (604) 528-5599
Fax: (604) 528-5593
Email: library@jibc.bc.ca
www.jibc.bc.ca/about/f-library.html

FEMA— Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472
Phone: (202) 566-1600
www.fema.org

Northwest regional center (serving: Alaska, Idaho, Oregon, Washington)
Federal Emergency Management Agency
Federal Regional Center
130 228th Street, SW
Bothell, WA 98021-9796
Tel: 425-487-4600
Fax: 425-487-4622

Canadian Red Cross
National Office
170 Metcalfe St.
Ottawa, Ontario K2P 2P2
Tel: (613)740-1900
Fax: (613)740-1911
feedback@redcross.ca
www.redcross.ca/index_english.html

American Red Cross
P.O. Box 37243
Washington, DC 20013
www.redcross.org/pubs/