

Introduction

Seismic Waves is a software modelling program which illustrates how seismic waves travel through the Earth after an earthquake. Its author (Alan Jones) has made it available as 'freeware' from <http://www.geol.binghamton.edu/faculty/jones>. The program is entitled **seiswave.exe**. It gives the user the option of looking at 7 different sites where there have been relatively recent tectonic events. There is a brief description of each one and the graphics allow the user to see a 3D representation of the Earth, a cross section of the Earth and seismograms from a variety of monitoring sites as surface, S and P waves travel through the Earth. The optional tutorial gives relevant details regarding the propagation of S and P waves which fulfil some of the requirements of current GCSE syllabuses.

Within the program it is possible to set a number of parameters. In its original downloaded form, the model's graphics are overly complex for the average KS4 student and contain information in excess of what is required at GCSE although it may be considered to be appropriate as extension/ enrichment work for the most able or those taking Separate Sciences. The instructions given in the technician notes allow for the setting up of a simplified version, which is more appropriate within the general context of KS4. The activity outlined below could be carried out as a teacher led activity using a LCD for a whole class demonstration but a more effective learning would be for students to use the programme in small groups.

Running the activity

It should be possible to run this activity as a self contained lesson (1hr approximately), with an extension task provided for early finishers. It is assumed that students will have already covered the concept of plate tectonics, the structure of the Earth, the refraction of light (KS3). The pupils' prior knowledge should be ascertained and the difference between longitudinal and transverse waves reinforced. The activity could be introduced using a LCD and the tutorial provided with the program, the pupils then going on to complete the tasksheet individually. At this stage the classroom teacher should be able to circulate, assessing progress and challenging individuals to produce their best work. It is worth asking the more able whether the simulation is a good reflection of reality (they may comment that there are no reflected waves represented).

More ideas

- Pupils could research the causes of earthquakes
www.exploratorium.edu/faultline/earthquakescience/index.html
- www.zephyrus.demon.co.uk/geography/resources/earth/cause.html
http://neic.usgs.gov/neis/plate_tectonics/rift_man.html
- Information about the Dudley, West Midlands earthquake in 23 September 2002
<http://www.earthquakes.bgs.ac.uk/>
- The effect of the recent earthquake on Kobe could be investigated
<http://www.zephyrus.demon.co.uk/geography/resources/earth/kobe.html>
www.earthquake.org/kobe.html
- Tsunamis could be described
www.geophys.washington.edu/tsunami/
www.pbs.org/wnet/savageearth/tsunami/
- What does it feel like to be in an earthquake?
www.zephyrus.demon.co.uk/geography/resources/earth/witness/eye.html

OK
OK

How are earthquakes predicted?

Learning outcomes

- Select relevant information from more than one source
- Develop ICT skills to communicate information
- The movement of the Earth's plates can give rise to earthquakes
- The study of seismic waves gives information about the layered internal structure of the Earth
- P (primary) waves are longitudinal (compressional), pass through both liquids and solids and travel faster than S (secondary) waves
- S waves are transverse (shear) and only travel through solids
- Surface waves transmit the most energy and cause most damage, whilst S waves typically transmit more energy than P waves
- The speed of waves changes when the state of the medium changes e.g. when P waves move from solid to liquid the speed decreases and the wave direction changes through refraction
- Refraction occurs at the boundaries between layers
- The Earth's outer core is liquid
- Earthquakes cause damage, but it is possible to minimise this through the careful design of structures e.g. bridges

Prior learning

- Pupils should be familiar with the idea that the Earth's lithosphere is made up of a number of moving tectonic plates (KS4)
- Waves transmit energy (not matter) and body waves can be either longitudinal or transverse (KS4) (NB this discriminates between body and surface waves, since surface waves are more complex. Body waves pass through the body of an object – while surface waves just disturb its surface, as waves on the ocean do.)
- Waves can be refracted (with reference to light at KS3)

Where the activity fits in

GCSE Syllabus (e.g. AQA Modular Double Award units, 15.4 and 21.6 H)

Skills

Communication, ICT.

Technician Notes Setting up *Seismic Waves*

Seismic Waves is 'freeware', meaning that there is no charge for its use. It is available for download from

<http://www.geol.binghamton.edu/faculty/jones>

Download **seiswave.exe**. Once installed there are a number of changes that need to be made to the settings in order to make the programme more accessible for KS4 learners.

There are two elements to the programme, *Seismic Waves Maintenance* and *Seismic Waves* itself. Opening *Seismic Waves Maintenance* allows the user access to the settings.

- Click on *Seismic Waves Maintenance*
- Click on *Preferences*
- Click on *Controls*
- From the dropdown menu ensure that *Title Bar*, *Menu Bar*, *Right Button Restarts*, *Select Components* and *Show Slider* are unchecked. Make sure that *Can Exit*, *Can Select View*, *Run From Script*, *Display Earthquake Information*, *Show Welcome Screen*, and *Run Tutorial* are checked.

These changes limit the pupils' access to certain elements of the programme and its appearance is less cluttered.

Removing the *Title Bar* and *Menu Bar* makes the screen less cluttered, whilst removing *Right Button Restarts*, *Select Components* and *Show Slider* limits the options to unnecessarily change programme settings.

The next changes are intended to make the appearance of the Earth's cross section which shows the propagation of seismic waves easier to interpret.

- In *Seismic Waves Maintenance* click on *Preferences*
- Click on *Phases*
- In the *Label all phases on view* box uncheck *Cross-section*
- In the *Which phases to show in cross-section* uncheck the *all* box and in the empty boxes below **type** the following seven waves – **P, S, PK, PKI, PKIK, PKIKP and PKP**.

K represents a wave in the core, whilst I represents a wave in the inner core, thus PKIKP shows a P wave moving through the mantle, outer core, inner core then through the outer core and back through the mantle.

It is also possible to turn the *Audio* output off. In a situation where more than one computer is being used this option is preferable since the noise generated is intrusive and does little to enhance the actual understanding of the science.

- Click on *Preferences* and select *Audio*
- Check the *No sound* box.

These changes should now leave the programme ready for the users.

A standard view of the simulation running is shown in Figure 1.

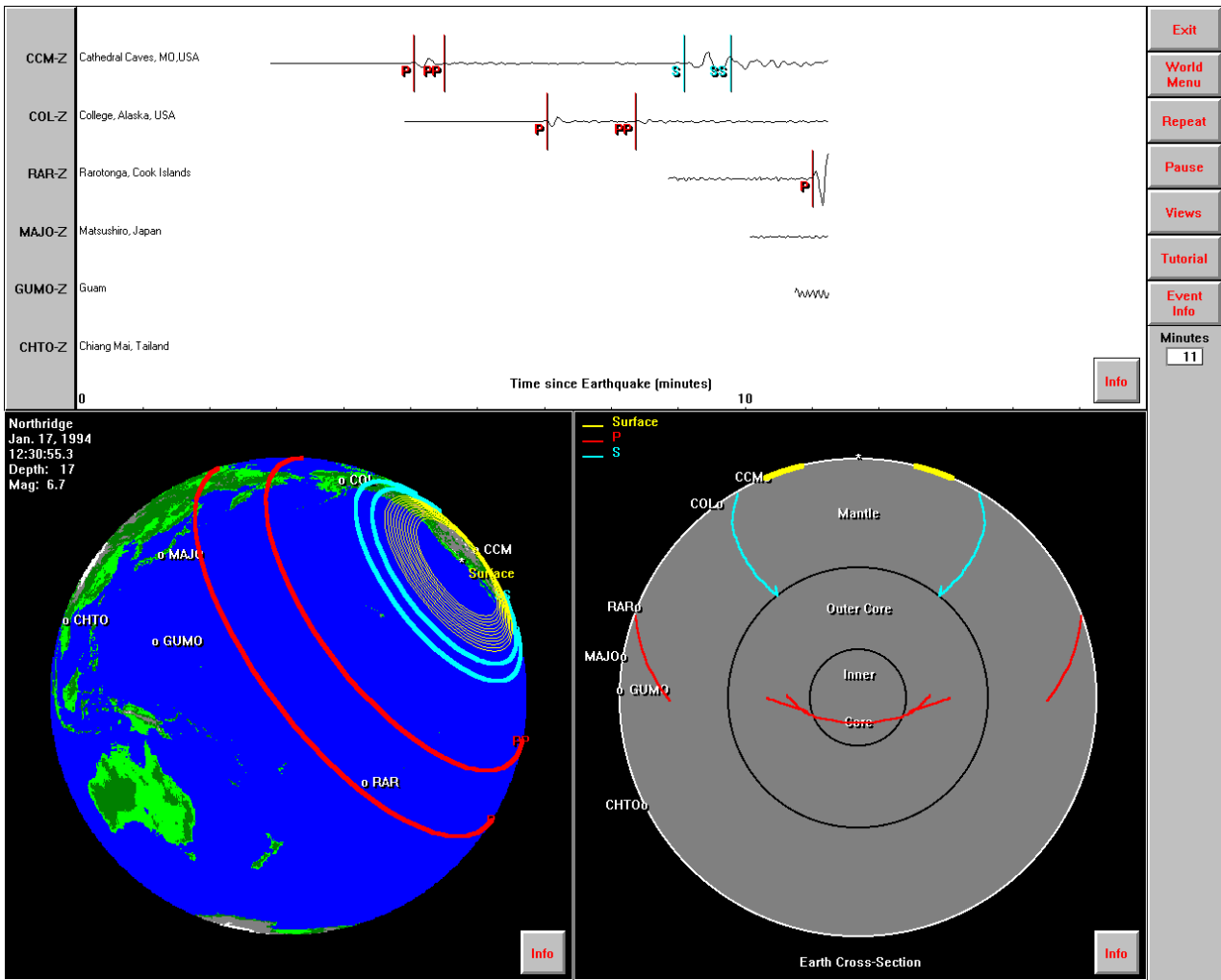


Figure 1

To change the view click 'Views'. Figure 2 is of the cross-section alone.

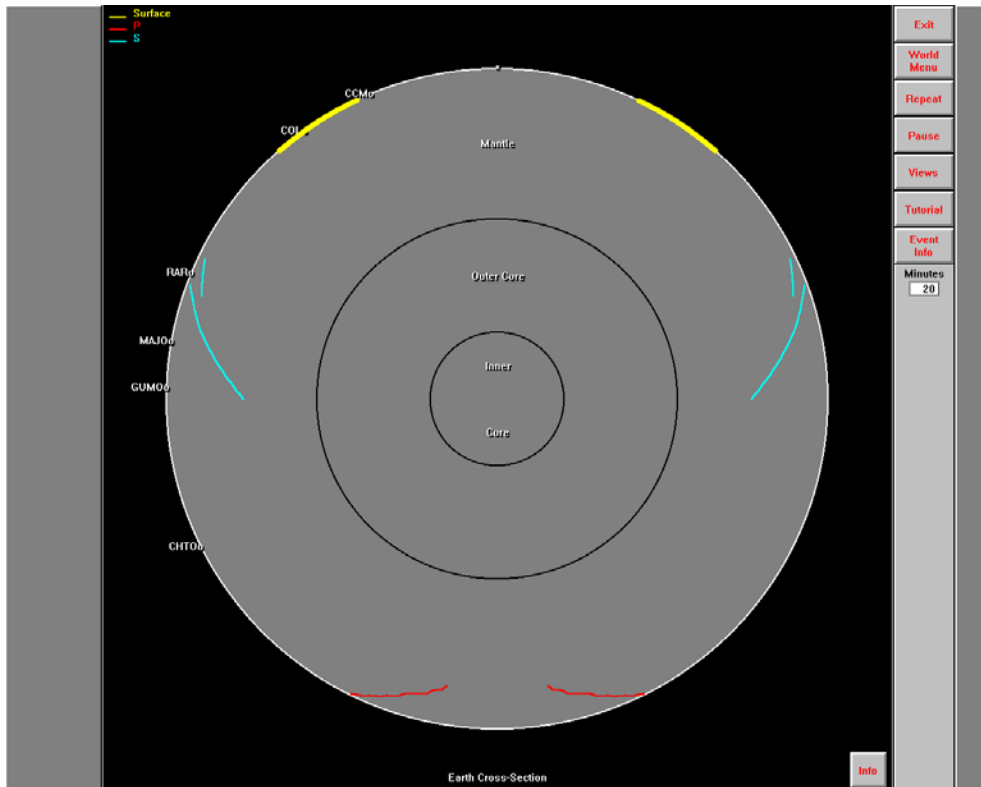


Figure 2