National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Earth and Space Science Level 2

This exemplar supports assessment against:

Achievement Standard 91188

Examine an Earth and Space Science issue and the validity of the information communicated to the public

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to examine comprehensively an Earth and Space Science (ESS) issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant ESS information that provides a comprehensive coverage of the issue • evaluating the validity of the information from different key sources communicated to the public, giving ESS reasons • justifying a position on the issue related to the processed ESS information, the conclusion drawn and the validity of the ESS information collected. This student has reported on the key theories for the P-Tr (Permian Triassic) boundary extinctions (1). The student has evaluated the validity and bias of the resources presented to the public (2), and given some justification for their final stand on the issue (3). For a more secure Excellence, the student could further justify the stand taken on the issue by stating the preferred theory and the reasons why. For example, the student could examine the cause of the Permian extinction event, and whether it was due to a series of events all happening at the same time: an asteroid collision, a volcanic trap eruption and oxygen depletion of the oceans.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate. The most accurate date given is that the extinction event is recorded in a study of zircons from rock sequences in multiple locations in southern China that date the extinction to 252.28±0.08ma. This date is the most accurate we have and has been cross-correlated by K/Ar and U/Pb dating methods, hence its validity. (2)

The Cause of the end-Permian Extinction: Five Theories

There are five leading theories that attempt to explain what happened at the end of the Permian. The main theories are: the impactor (bolide) theory, the volcanism theory, the regression theory, the oceanic overturn theory and the methane catastrophe theory. (1)

1. Impactor

The impactor theory is inspired by the success of the Alvarez's explanation for the end-Cretaceous catastrophe. Clearly the impact from this asteroid or comet caused an extraordinary catastrophe for many organisms. Obviously, according to impactor advocates, an even larger impactor would have the energy to do even greater damage to the biosphere. Consequently, the impactor theory has had a strong appeal and needs to be examined.

The problem with the impactor proposal, however, is that there has been no evidence to support it. There is no iridium layer, as found at the Cretaceous-Tertiary boundary. There is no accepted evidence for shocked quartz. There are no microtektites -- or the clay spherules which the microtektites by now would have weathered into. There are no tsunami deposits that record a great impact in the ocean. No impact crater has been located.

2. Volcanism

The second theory regarding the cause of the end-Permian catastrophe is the volcanism theory. Unlike the impactor theory, the volcanism theory starts with extraordinarily good evidence. The Siberian Traps eruptive event was a large event. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe.

There have been continuing suggestions that Traps volcanism could have been triggered by an impact. Again, this is not an unreasonable proposal. Impactors do have extraordinary destructive power.

3. Catastrophic Regression

This theory enjoyed some support about a decade ago, but that support seems to have waned. The basic idea is that the end-Permian extinction was caused by a major drop

(regression) in the global sea level. This regression may have been as great as 280 meters though others suggest it was far less. This would have reduced shallow ocean areas.

4. Ocean Anoxia – lack of oxygen/increase in hydrogen sulfide.

Several studies have indicated that the Late Permian to Early Triassic Ocean was partially or even significantly anoxic (lacking in oxygen). The anoxia constituted the cause of the end-Permian extinction. Oceanic anoxia is an excellent mechanism for killing off aerobic marine organisms. A lack of oxygen caused sulfur-reducing bacteria to dominate the seas causing the release of hydrogen sulfide that killed off many marine species.

5. Continental Margin Methane Release

Permafrost and seafloor methane hydrate release may have played a role in the end-Permian extinction. The seabed probably contained methane hydrate deposits, and the lava caused the deposits to dissociate, releasing vast quantities of methane causing temperature changes.

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society produces resources that explain the geology in layman's terms. Wikipedia has a good series of accounts for the "great dying" and these are backed up with links to geological sources worldwide. *Scientific American* has a series of articles related to this extinction event and produces reports for the general public. The resources on the internet are written by geologists and though there are many competing reasons for the "great dying" these resources are valid but do show a bias to the geographic area the geologists work in. All scientists follow the scientific method so bias is expected but the scientific method explains this bias. For example, Australian geologists show a real interest in the impactor theory because there is a structure off the NW coast of Australia of about the correct age: the Bedout structure. It is yet to be proven it is an impact structure. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian (250ma). What caused it is still up to negotiation. The final answer is possibly a series of events rather than one single event. Possible causes supported by strong evidence appear to describe a sequence of catastrophes, each one worse than the last. The Siberian Traps eruptions were bad enough in their own right, but because they occurred near coal beds and the continental shelf, they also triggered very large releases of carbon dioxide and methane. The resultant global warming may have caused perhaps the most severe anoxic event in the oceans' history. According to this theory, the oceans became so anoxic, anaerobic sulfur-reducing organisms dominated the chemistry of the oceans and caused massive emissions of toxic hydrogen sulfide. (3)

	Grade Boundary: High Merit
2.	For Merit the student needs to examine in depth an Earth and Space Science (ESS) issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant ESS information that provides a wide coverage of the issue • comparing the validity of the information from different key sources communicated to the public, giving ESS reasons • stating a position on the issue related to the processed ESS information and the conclusion drawn. This student has reported on the key theories for the P-Tr (Permian Triassic) boundary extinctions (1). The student has compared the validity of the resources presented to the public (2) and explained the final stand taken on the issue (3). To reach Excellence, the student could expand on the validity of the information and explain the bias of the authors in the resources used. A more accurate identification of the geological age would make findings more valid and a justification of their position on the issue is expected.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate.

The Cause of the end-Permian Extinction: Five Theories

There are five leading theories that attempt to explain what happened at the end of the Permian. The main theories are: the impactor (bolide) theory, the volcanism theory, the regression theory, the oceanic overturn theory, and the methane catastrophe theory. (1)

1. Impactor

The impactor theory is, inspired by the success of the Alvarez's explanation for the end-Cretaceous catastrophe. Clearly the impact from this asteroid or comet caused an extraordinary catastrophe for many organisms. Obviously, according to impactor advocates, an even larger impactor would have the energy to do even greater damage to the biosphere. Consequently, the impactor theory has had a strong appeal and needs to be examined.

The problem with the impactor proposal, however, is that there has been no evidence to support it. There is no iridium layer, as found at the Cretaceous-Tertiary boundary. There is no accepted evidence for shocked quartz. There are no microtektites -- or the clay spherules which the microtektites by now would have weathered into. There are no tsunami deposits that record a great impact in the ocean. No impact crater has been located.

2. Volcanism

The second theory regarding the cause of the end-Permian catastrophe is the volcanism theory. Unlike the impactor theory, the volcanism theory starts with extraordinarily good evidence. The Siberian Traps eruptive event was a large event. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe.

There have been continuing suggestions that Traps volcanism could have been triggered by an impact. Again, this is not an unreasonable proposal. Impactors do have extraordinary destructive power.

3. Catastrophic Regression

This theory enjoyed some support about a decade ago, but that support seems to have waned. The basic idea is that the end-Permian extinction was caused by a major drop (regression) in the global sea level. This regression may have been as great as 280 meters though others suggest it was far less. This would have reduced shallow ocean areas.

4. Ocean Anoxia – lack of oxygen/increase in hydrogen sulfide.

Several studies have indicated that the Late Permian to Early Triassic Ocean was partially or even significantly anoxic (lacking in oxygen). The anoxia constituted the cause of the end-Permian extinction. Oceanic anoxia is an excellent mechanism for killing off aerobic marine organisms. A lack of oxygen caused sulfur-reducing bacteria to dominate the seas causing the release of hydrogen sulfide that killed off many marine species.

5. Continental Margin Methane Release

Permafrost and seafloor methane hydrate release may have played a role in the end-Permian extinction. The seabed probably contained methane hydrate deposits, and the lava caused the deposits to dissociate, releasing vast quantities of methane causing temperature changes.

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society produces sources that explain the geology in layman's terms. Wikipedia has a good series of accounts for the "great dying" and these are backed up with links to geological sources worldwide. The resources on the internet are written by geologists and are therefore valid and unbiased. The age of the event is about 250ma and was dated by radiometric dating techniques. These methods are valid and accurate for geologists. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian (250ma). What caused it is still up to negotiation. Possible causes supported by strong evidence appear to describe a sequence of catastrophes, each one worse than the last. the Siberian Traps eruptions were bad enough in their own right, but because they occurred near coal beds and the continental shelf, they also triggered very large releases of carbon dioxide and methane. The resultant global warming may have caused the extinction event. (3)

	Grade Boundary: Low Merit
3.	For Merit the student needs to examine in depth an Earth and Space Science issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant ESS information that provides a wide coverage of the issue • comparing the validity of the information from different key sources communicated to the public, giving ESS reasons • stating a position on the issue related to the processed ESS information and the conclusion drawn. This student has reported on some key theories for the P-Tr (Permian Triassic) boundary extinctions (1). The student has compared the validity of some resources presented to the public (2) and given a final stand on the issue (3). For a more secure Merit, the student could look at additional theories about the P-Tr extinction event. Providing an accurate age of the event would increase the validity of the stated theory. Bias needs to be commented on. An explanation of a final position on the issue is expected.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate.

The Cause of the end-Permian Extinction: Four Theories

There are four leading theories that attempt to explain what happened at the end of the Permian. The main theories are: the impactor (bolide) theory, the volcanism theory, the regression theory and the oceanic anoxia theory. (1)

1. Impactor

The impactor theory is inspired by the success of the Alvarez's explanation for the end-Cretaceous catastrophe. Clearly the impact from this asteroid or comet caused an extraordinary catastrophe for many organisms. Obviously, according to impactor advocates, an even larger impactor would have the energy to do even greater damage to the biosphere. Consequently, the impactor theory has had a strong appeal and needs to be examined.

The problem with the impactor proposal, however, is that there has been no evidence to support it. There is no iridium layer, as found at the Cretaceous-Tertiary boundary. There is no accepted evidence for shocked quartz. There are no microtektites -- or the clay spherules which the microtektites by now would have weathered into. There are no tsunami deposits that record a great impact in the ocean. No impact crater has been located.

2. Volcanism

The second theory regarding the cause of the end-Permian catastrophe is the volcanism theory. Unlike the impactor theory, the volcanism theory starts with extraordinarily good evidence. The Siberian Traps eruptive event was a large event. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe.

There have been continuing suggestions that Traps volcanism could have been triggered by an impact. Again, this is not an unreasonable proposal. Impactors do have extraordinary destructive power.

3. Catastrophic Regression

This theory enjoyed some support about a decade ago, but that support seems to have waned. The basic idea is that the end-Permian extinction was caused by a major drop (regression) in the global sea level. This regression may have been as great as 280 meters though others suggest it was far less. This would have reduced shallow ocean areas.

4. Ocean Anoxia – lack of oxygen/increase in hydrogen sulfide.

Several studies have indicated that the Late Permian to Early Triassic Ocean was partially or even significantly anoxic (lacking in oxygen). The anoxia constituted the cause of the end-Permian extinction. Oceanic anoxia is an excellent mechanism for killing off aerobic marine organisms. A lack of oxygen caused sulfur-reducing bacteria to dominate the seas causing the release of hydrogen sulfide that killed off many marine species.

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society produces sources that explain the geology in layman's terms. Wikipedia has a good series of accounts for the "great dying" and these are backed up with links to geological sources worldwide. The resources on the internet are written by geologists and are valid. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian (250ma). What caused it is still up to negotiation. Possible causes supported by strong evidence appear to describe a sequence of bad events, each one worse than the last: The Siberian Traps eruptions were bad enough in their own right, but when combined with the impactor event 90% of life on this planet disappeared. (3)

	Grade Boundary: High Achieved
4.	For Achieved the student needs to examine an Earth and Space Science (ESS) issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant ESS information on the issue • commenting on the validity of the information from key sources communicated to the public • drawing a conclusion on the issue. This student has described key events that may have caused the P-Tr (Permian Triassic) boundary extinctions (1) The validity of resources has been commented on (2) and a stand on the issue has been given, with a reason for the stand (3). To reach Merit, the student could explain other explanations for the extinctions, expand on discussion of the validly of the resources used and on the bias of the authors and provide more reasons for the conclusion drawn.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate.

The Cause of the end-Permian Extinction: Three Theories

There are three leading theories that attempt to explain what happened at the end of the Permian. The main theories are: the impactor (bolide) theory, the volcanism theory and the anoxia theory. (1)

1. Impactor

The impactor theory is inspired by the success of the Alvarez's explanation for the end-Cretaceous catastrophe. Clearly the impact from this asteroid or comet caused an extraordinary catastrophe for many organisms. Obviously, according to impactor advocates, an even larger impactor would have the energy to do even greater damage to the biosphere. Consequently, the impactor theory has had a strong appeal and needs to be examined.

The problem with the impactor proposal, however, is that there has been no evidence to support it. There is no iridium layer, as found at the Cretaceous-Tertiary boundary. There is no accepted evidence for shocked quartz. There are no microtektites -- or the clay spherules which the microtektites by now would have weathered into. There are no tsunami deposits that record a great impact in the ocean. No impact crater has been located.

2. Volcanism

The second theory regarding the cause of the end-Permian catastrophe is the volcanism theory. Unlike the impactor theory, the volcanism theory starts with extraordinarily good evidence. The Siberian Traps eruptive event was a large event. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe.

There have been continuing suggestions that Traps volcanism could have been triggered by an impact. Again, this is not an unreasonable proposal. Impactors do have extraordinary destructive power.

3. Ocean Anoxia – lack of oxygen/increase in hydrogen sulfide.

Several studies have indicated that the Late Permian to Early Triassic Ocean was partially or even significantly anoxic (lacking in oxygen). The anoxia constituted the cause of the end-Permian extinction. Oceanic anoxia is an excellent mechanism for killing off aerobic marine organisms. A lack of oxygen caused sulfur-reducing bacteria to dominate the seas causing the release of hydrogen sulfide that killed off many marine species.

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society produces sources that explain the geology in layman's terms. Wikipedia has good resources as well. The resources on the internet are written by geologists and are therefore correct and valid. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian. (250ma).What caused it is still up to negotiation. I think it was caused by the Siberian Traps because we can still see evidence of them today. (3)

	Grade Boundary: Low Achieved
5.	For Achieved the student needs to examine an Earth and Space Science (ESS) issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant ESS information on the issue • commenting on the validity of the information from key sources communicated to the public • drawing a conclusion on the issue. This student has described two events that may have caused the P-Tr (Permian Triassic) boundary extinctions (1). The validity of resources has been commented on (2) and a stand on the issue has been given (3). For a more secure Achieved, the student could have commented more on the causes given for the extinction event, the validity of the resources used and more fully linked the conclusion to the resources used.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate.

The Cause of the end-Permian Extinction: Five Theories

There are two key theories that attempt to explain what happened at the end of the Permian. The main theories are: the impactor (bolide) theory and the volcanism theory. (1)

1. Impactor

The impactor theory is inspired by the success of the Alvarez's explanation for the end-Cretaceous catastrophe. Clearly the impact from this asteroid or comet caused an extraordinary catastrophe for many organisms. Obviously, according to impactor advocates, an even larger impactor would have the energy to do even greater damage to the biosphere. Consequently, the impactor theory has had a strong appeal and needs to be examined.

The problem with the impactor proposal, however, is that there has been no evidence to support it. There is no iridium layer, as found at the Cretaceous-Tertiary boundary. There is no accepted evidence for shocked quartz. There are no microtektites -- or the clay spherules which the microtektites by now would have weathered into. There are no tsunami deposits that record a great impact in the ocean. No impact crater has been located.

2. Volcanism

The second theory regarding the cause of the end-Permian catastrophe is the volcanism theory. Unlike the impactor theory, the volcanism theory starts with extraordinarily good evidence. The Siberian Traps eruptive event was a large event. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe.

There have been continuing suggestions that Traps volcanism could have been triggered by an impact. Again, this is not an unreasonable proposal. Impactors do have extraordinary destructive power.

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society has explained how the Siberian traps were made. The traps formed big volcanoes. Wikipedia has good resources as well. The resources on the internet are written by geologists and are therefore correct. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian (250ma). I think it was caused by the Siberian Traps. (3)

	Grade Boundary: High Not Achieved
6.	For Achieved the student needs to examine an Earth and Space Science (ESS) issue and the validity of the information communicated to the public. This involves: • selecting, processing and reporting on relevant Earth and Space Science information on the issue • commenting on the validity of the information from key sources communicated to the public • drawing a conclusion on the issue. This student has described a single event that may have caused the P-Tr (Permian Triassic) boundary extinctions (1). Resources have been commented on (2) and a stand on the issue has been stated (3). To reach Achieved the student could have looked at other causal events as well as volcanism. The student also needs to comment on why research sources selected were valid.

The Great Dying: the extinction of life at the end of the Permian (P-Tr) 250 million years ago.

250 million years ago the world underwent the “great dying”. Over 90% of life on this planet vanished. Many major geological species, like trilobites, disappeared. Just what caused this extinction is still open to public debate.

The Cause of the end-Permian Extinction: The top theory

The key theory for the extinction event at the end of the Permian is volcanism in the Siberian traps in Russia.

1. Volcanism

The main theory regarding the cause of the end-Permian catastrophe is the volcanism theory. The volcanism theory has extraordinarily good evidence. The Siberian Traps eruptive event was a large event and the flood basalts today show it was a huge volcano. There has been little doubt that Traps volcanism was somehow involved with the end-Permian catastrophe. (1)

Validity of the information communicated to the public.

Information that is presented comes mainly from reputable geological sources. The US geological society has explained how the Siberian traps were made by volcanoes. The traps formed big volcanoes. Wikipedia has good resources as well. The resources on the internet are written by geologists and are therefore correct. (2)

Conclusion:

There is no doubt that the Earth suffered a major extinction event at the end of the Permian. (250ma). I think it was caused by the Siberian Traps. (3)