

# The Ø 1270 x 950 km Permian Triassic Impact Crater - Summary of the geophysical evidence

Please also read : [Part 1](#) to [Part 6](#) of my PT-Impact Hypothesis - more infos at : [www.permiantriassic.de](http://www.permiantriassic.de) ( or : [www.permiantriassic.at](http://www.permiantriassic.at) )

by Harry K. Hahn / Germany - 26.9.2021 - ( Update : 8.8.2022 ) - **Note** : This document is not allowed for commercial use !

## Abstract :

This is a summary of geophysical evidence for the Ø 1270 x 950 km Permian Triassic (PT)-Impact Crater which I have discovered and described in my hypothesis Part 1 to Part 6. A topographic map and a satellite image of the Arctic Ocean area, Alaska and Siberia provided the first indication for the PT-Impact Crater and –impact event. The similarities of structures visible on the topographic map to the structures calculated by a computer simulation of a shallow (oblique) impact with an impact angle of 5°, provide a strong indication for the existence of the Ø 1270 x 950 km PT-Impact Crater on the Arctic Ocean floor.

Especially the elliptical deep sea basin in the Arctic Ocean, the bow-shaped Brooks Range in Alaska and the northern edge of the Central Siberian Plateau (Siberian Traps), which has the same bow-wave- structure, are strong indicators that the PT-Impact Crater was caused by a shallow impact of an asteroid or comet.

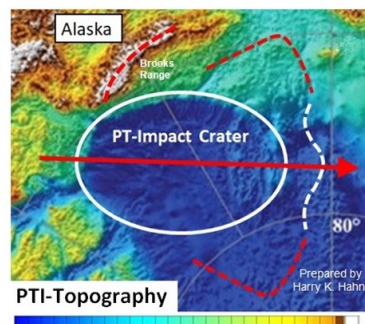
Further strong indication for the PT-Impact-Crater comes from a gravity anomaly map and from a magnetic anomaly map of the Arctic Ocean area and Alaska. The gravity anomaly map clearly shows sections of the elliptical crater-wall of the PT-Impact Crater (positive anomalies) . The Brooks Range in Alaska, which originally was part of the elliptical crater structure, is also indicated by a positive anomaly on the map. But this former section of the elliptical crater-wall drifted away from the PT-Crater, caused by forces of the massive amounts of ejecta material that was ejected from the crater, which probably was in the range of 100.000.000 to 200.000.000 km<sup>3</sup> of ejecta material ! The majority of the crater floor is visible as a negative anomaly (blue) on the map. The magnetic anomaly map of the Arctic Ocean area shows a triangular-shaped positive anomaly (red), which originates from the crater center. This indicates ejecta that was coming from an iron-rich impactor.

The big distance between the elliptical impact basin and the described bow-wave-shaped structure in Siberia, which originally was located directly at the front-end of the PT-Crater, is the result of a divergent tectonic motion and expansion tectonics process that was triggered by the shallow PT-impact. The leading edges (front edges) of the two gigantic ejecta wings which were caused by the PT-Impact, cut through Earth's crust and massive amounts of ejecta material and impactor material (e.g. iron) descended into Earth's mantle and caused the Pacific-LLSVP and the African-LLSVP. All volcanos of the Pacific Fire Ring and all volcanism on Earth can be explained solely by the PT-Impact !

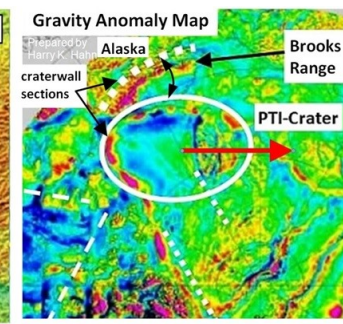
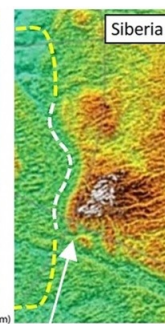
I also present six possible secondary craters of the PT-Impact Event in Europe & Australia and Raman spectroscopic analyses which provide proof for the PT-Impact (see: [Part 6 \(P6\)](#)) Raman spectroscopic analyses results and images of Rock Samples & Sample Sites are also available on my website : [www.permiantriassic.de](http://www.permiantriassic.de) ( or : [www.permiantriassic.at](http://www.permiantriassic.at) )



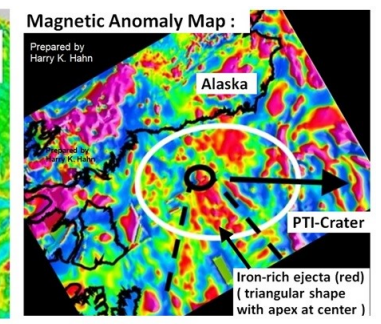
A shallow impact causes two ejecta wings with powerful leading edges



PTI-Topography

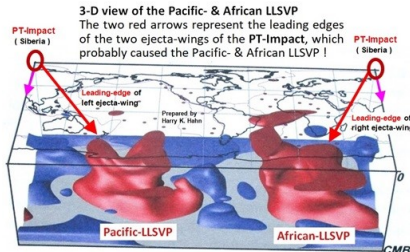


Gravity Anomaly Map

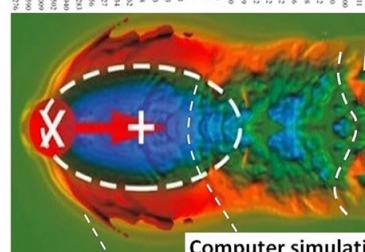


Magnetic Anomaly Map : Iron-rich ejecta (red) (triangular shape with apex at center)

Because of the expansion tectonics process that is obviously going on in Earth's mantle since the PT-Impact, a revised model for Earth's mantle is required, which must consider a mantle that is probably consisting of a mixture of silicate minerals and high-pressure Ice, e.g. **Ice X** & **Ice XI** with a high density  $\geq 3$ , which goes through a phase change because of the hot LLSVP-areas, towards a lower density, and is expanding Earth's mantle in this process ! **Note** : The water of Earth's oceans originates in Earth's mantle, and the PT-Impact has increased the release of super-heated salty "mantle-water" into the oceans along the mid-ocean ridges.



3-D view of the Pacific- & African LLSVP The two red arrows represent the leading edges of the two ejecta-wings of the PT-Impact, which probably caused the Pacific- & African LLSVP !



Computer simulation

Note similarity of bow-shaped structure !  
→ structure was caused by the motion of the impactor along the surface

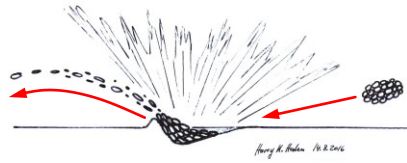
The elliptical deep sea basin in the Arctic Sea, the bow-shaped Brooks Range in Alaska and the northern edge of the Central Siberian Plateau, which has the same bow-wave- structure as the simulated structure, are strong indicators for the PT-Crater.

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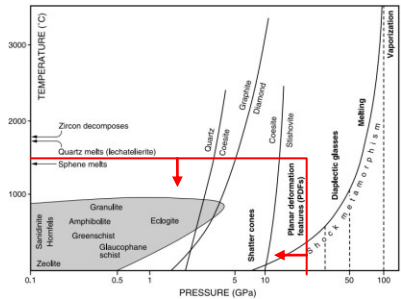
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# Geophysical proof of the Ø 1270 x 950 km Permian Triassic Crater and summary of the mineralogical evidence

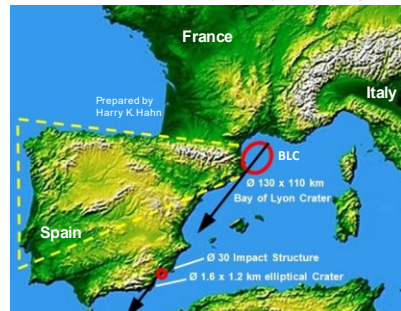
by Harry K. Hahn / Germany - 22.7.2021 - more info at: [www.permiantriassic.de](http://www.permiantriassic.de) or at: [Part 6 \(P6\)](#) of my PTI-hypothesis



The PT-**Impact Crater** was formed by a very shallow impact with low shock pressures

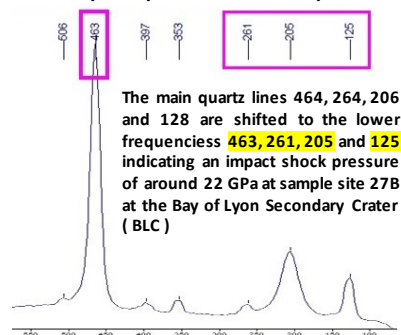


Shock metamorphic effects in PTI-ejecta → red marked box (shock metamorphism diagram)



This map shows the three most interesting PT-Secondary Craters for further research in Europe, according to my analysis. The Ø130x110 km "Bay of Lyon Crater", the Ø30 km and the Ø1.6x1.2 km Impact Craters

The Raman Spectra of quartz grains from sample site 27B at the BLC shows a clear shift of main quartz peaks to lower frequencies



The main quartz lines 464, 264, 206 and 128 are shifted to the lower frequencies 463, 261, 205 and 125 indicating an impact shock pressure of around 22 GPa at sample site 27B at the Bay of Lyon Secondary Crater (BLC)

To proof an impact-crater **shock-metamorphic effects** must be found which provide the evidence for the impact crater. In the case of the Ø 1270 x 950 km Permian Triassic Crater described in my hypothesis ( [Part 1 to 4](#) of my study ) this isn't an easy job ! ( → mineralogical evidence in [Part 6 \(P6\)](#) ).

## Two main reasons why it's difficult to proof the PT-Crater :

- 1.) The PT-Crater is located on the ocean floor of the **Arctic Ocean** in > 2000 m depth, and it is filled with sediments.
- 2.) The PT-Crater was caused by an oblique impact. This means the impactor, an asteroid or comet with a Ø 60 to 200 km, impacted in a very shallow angle of less than 8° with an impact velocity of < 8 km/s (=orbital velocity of a small moonlet close to Earth ). That's why **the impactor impacted and moved in a nearly horizontal direction** along Earth's surface, excavating big amounts of crust- & mantle-material.

Therefore the impact pressure caused during the impact was relatively low and **most of the ejecta material** that was ejected **from the PT-Crater was exposed to a shock pressure of probably less than 20 GPa**. Impact glass probably doesn't exist in this ejecta material. And shock-metamorphed minerals like Coesite probably only exist in small amounts.

The same is true for all secondary structures caused by ejecta from the PT-Crater. The shock-pressure was mainly < 20 GPa

**Exceptions seem to be real PT-Secondary Craters** which can clearly be identified on topography-, magnetic- and gravity-anomaly maps as crater structures. Here shock-metamorphic effects can be found in rocks inside of the crater, in the crater-rim area or close to the Crater ( e.g. Cape York Crater )

**My analysis indicates that shock-pressures in the range of 22-24 GPa can be identified in / near such Secondary Craters**

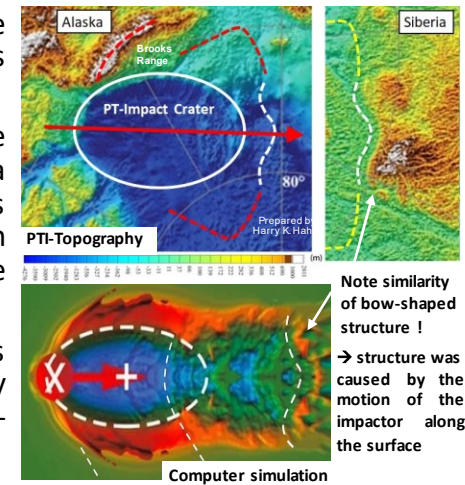
These impact shock-pressures can be identified with the help of **PDFs** or with **Micro-Raman Spectroscopy** on quartz grains

**The Ø130x110km Bay-of-Lyon Crater and the Ø30km Impact Structure and the Ø1.6x1.2km Impact Crater in Spain are the most interesting PT-Secondary-Craters for further scientific research in Europe ( → proof of PT-**Impact Event** ! ). And the Ø320 km Cape York Crater and the Ø40x33km Pilbara Crater are the most interesting PT-Secondary Craters in Australia.** Detailed information about the material that was ejected by the PT-Crater can be found in studies about the **Siberian Traps**

The geophysical evidence for the Ø 1270 x 950 km PT-**Impact Crater** is provided by different map types.

According to my hypothesis, the similarities of structures visible on a topographic map, to structures calculated by a computer simulation provide the most impressive indication (proof) for the PT-Crater !

Further indication for the enormous PT-**Impact Crater** described in my hypothesis comes from a gravity-anomaly- & magnetic anomaly map.



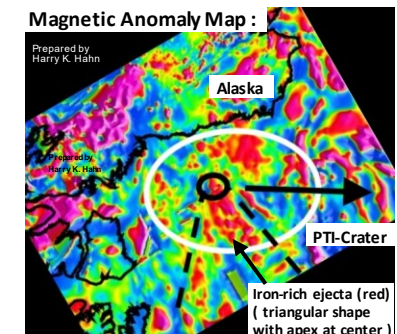
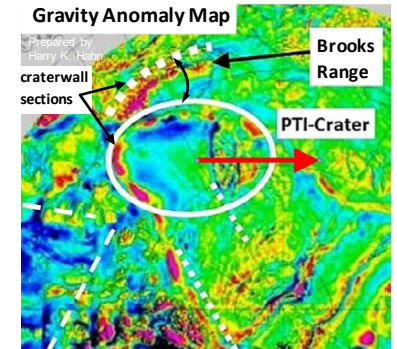
Note similarity of bow-shaped structure ! → structure was caused by the motion of the impactor along the surface

The gravity anomaly map is clearly indicating the elliptical PT-Crater and a section of the elliptical crater-rim that drifted away from the PT-Crater caused by forces of the escaping ejecta. This former section of the crater-rim is the **Brooks Range** in Alaska which indicates a formation age of ≈ 250 Ma ! Further there are linear structures noticeable, caused by ejecta rays.

The magnetic anomaly map shows a distinct triangular-shaped structure with the apex of the structure being congruent with the PT-Crater center.

This indicates iron-rich ejecta that was ejected from the PT-Crater ( red color )

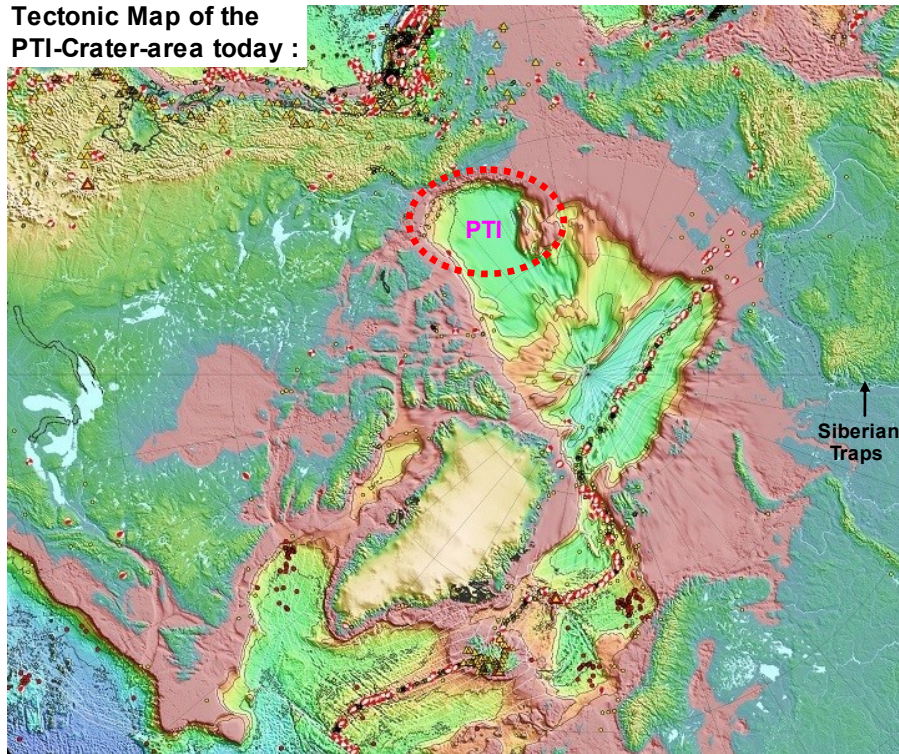
Further evidence comes from the distribution pattern and outline of the **Siberian Traps**. The map on the right shows the PTI-Crater in reference to the Siberian Traps as it was located at the time of the Impact. The trajectory of the impactor fits perfectly to the "main flow-direction" of the Siberian Traps ( red ). **Note :** The PTI ejected ≈ 100.000.000 - 200.000.000 km<sup>3</sup> material



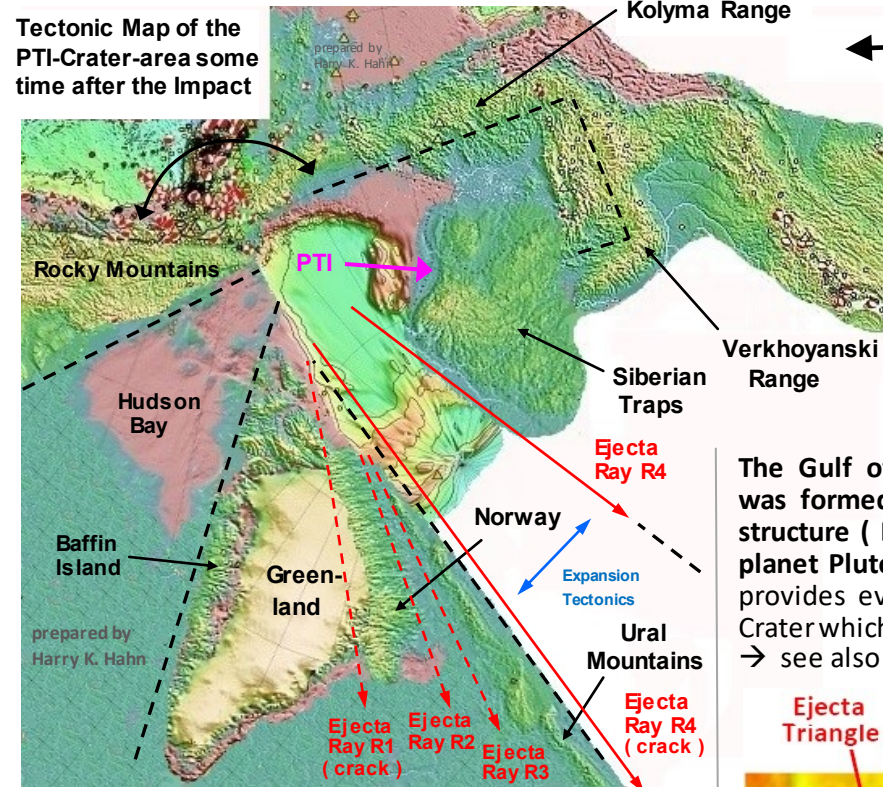
# A re-constructed Tectonic Map of the Ø 1270 x 950 km Permian-Triassic Crater-area a certain time after the Impact Event

I have re-arranged some key-areas of the Tectonic- (Topographic-) Map of the PTI-Crater-area to provide a clearer picture of the deformations which the PT-Impact caused on Earth's crust. This will make it a bit easier for Tectono-physicists ( Geo-physicists ) to confirm and accept the existence of the PT-Crater and the Expansion Tectonics process that obviously was triggered by this Impact Event !

Tectonic Map of the PTI-Crater-area today :



Tectonic Map of the PTI-Crater-area some time after the Impact



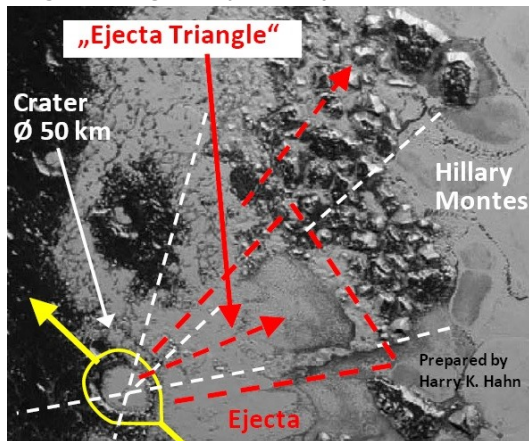
→ Page added on 18.1.2022

← The manipulated tectonic- (topographic-) map on the left shows the PT-Impact area as it probably looked a certain time after the Impact. The Hudson Bay (CA) and the Kolyma Range in Siberia were caused by ejecta-lobes of the PTI, which show the same ejecta triangle structure as an impact on planet Pluto and as two other secondary impacts caused by the PTI (see below)

The Gulf of Carpentaria in NE-Australia was formed by a similar ejecta-impact-structure ( Ejecta-Triangle ) as visible on planet Pluto. → This "Ejecta Triangle" provides evidence for another ≈ 300 km Crater which is hidden on the ocean floor. → see also page 13 in Part 2 ( or: Part-2 )

## Other shallow Impacts which caused „Ejecta-Triangles“ :

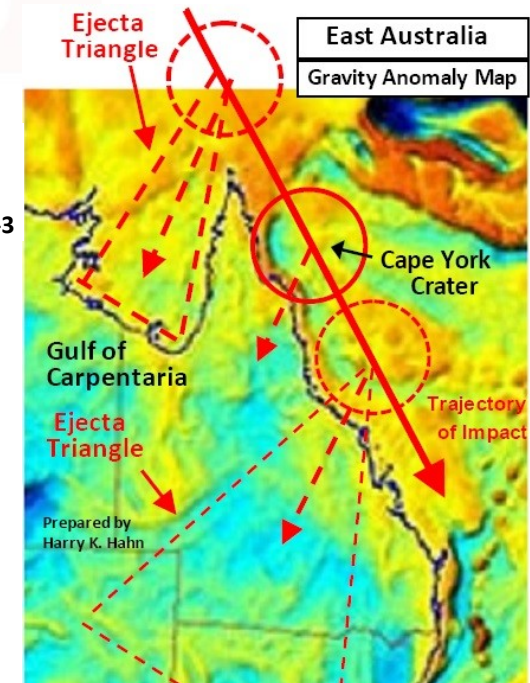
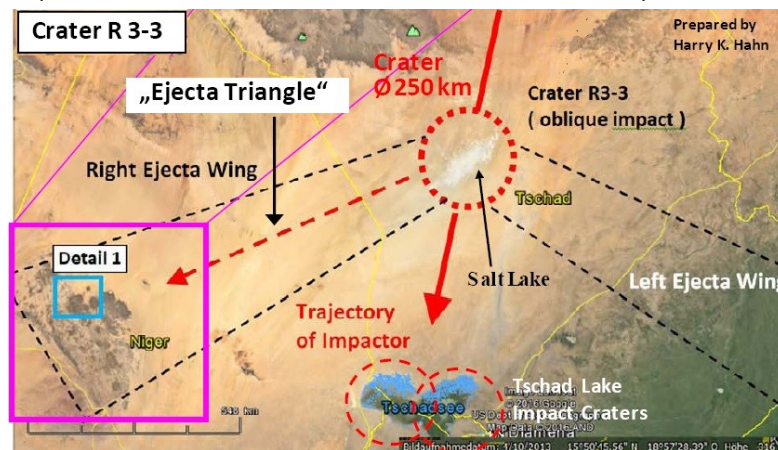
A Ø 50 km Crater on planet Pluto caused a large „Triangular Ejecta Impact Structure“



A shallow (oblique) Impact Event on Pluto, less than 100 million years ago, formed **Hillary Montes** at the border line of **Sputnik Planum**.

An ejecta-lobe (wing) from the impact-crater produced an Ejecta-Impact-Structure with a precise triangular shape ! ( → red lines ) ( → see: Pluto Images )

A big ≈ Ø 250 km Crater in Ejecta Ray R3 shows an „Ejecta Triangle“  
The gravity anomaly map and satellite images show a similar "Ejecta-Impact-structure" as on Pluto → in North-Africa, caused by the Crater R3-3



## Indication and evidence for the Permian-Triassic (PT) Impact Event which is coming from present studies :

A number of scientists specialized in impact research already proposed, that the Siberian Traps, the largest eruption of continental flood lavas on Earth, may be better explained by a large Impact than by a conventional mantle plume. Unfortunately the scientists haven't found the impact crater yet !

With my study ( Parts 1 to 6 ) I want to proof that **Global Impact Events\* are the primary cause for Plate-Tectonics** ( and Expansion-Tectonics ) on Earth and on other planets and moons of our solar system, and that such a Global Impact Event caused the formation of Continents and Oceans on Earth !

The hard evidence for the correctness of my hypothesis, is the confirmation of the **Ø 1270x950 km Permian-Triassic (PT) Impact Crater** described in my study

In the following I want to show now some extracts from a book written by the well-known impact researcher Prof. Dr. Christian Koeberl.

These extracts from the book show the existing indication and evidence for a Permian-Triassic ( PT ) Impact Crater. But no information is given for its location.

The title of the book : "Impact Markers in the Stratigraphic Record" – Authors : C. Koeberl & F. Martinez-Ruiz ( ISBN : 3-540-00630-3 )

### Here the extracts from the book :

Page 29 : Siderophile element anomalies ( e.g. enhanced Ir contents ) were found at some P-Tr boundary locations ( e.g., Holser et al. 1989 ). And recent research succeeded in demonstrating the P-Tr boundary event was a much shorter event than thought. At Meishan, China, a negative excursion in the carbon isotopic composition had a duration of less than about 160,000 years and suggested that it could be the result of the impact of an icy carbon-rich comet.

Page 29 : Kaiho et al. (2001) reported sulfur isotope and chemical data for samples from the Meishan (China) Permian-Triassic (P-Tr) boundary section. They interpreted S-isotope data, as well as the occurrence of Fe- and Ni-rich particles, as evidence for a large-scale impact event that penetrated the Earth's mantle and formed a crater approximately 1000 km in diameter.

A number of scientists pointed out that the Siberian Traps cannot be the result of a mantle plume ( e.g. Czamanske et al. 1998, Sharma 1997, Elkins-Tanton and Hager 2000 )

Page 109 : An impact event is also supported by evidence from extraterrestrial noble gases in fullerenes found in P-Tr boundary beds in China, Japan, Hungary.

Page 109 : Because there is a similar duality of signals between likely volcanic and impact sources at the P-Tr boundary, similar to the K-T boundary, the hypothesis of Impact Researchers should be tested, which claims that the Siberian Traps could have been caused by decompression melting at the impact site. And that impact volcanism can uniquely explain the dual signals in the geological record.

Page 110 : An indicative model of Impact Researchers shows that it is possible for the volume of decompressed mantle beneath a large ~ 200 km sized crater to greatly exceed the excavated volume of the impact crater itself, primarily due to reduction of lithostatic load. Under suitable conditions of geothermal gradient, this would lead to near instantaneous melting with volumes of the order of  $10^6 \text{ km}^3$ , similar to the characteristic volumes of LIP's.

Page 110 : And the induced large-scale vertical and horizontal thermal gradients are expected to have a long-term effect on secondary mantle flow.

Page 111 : Decompression melting may contribute more melt than conventional shock melting.

Page 111 : We propose that the Siberian Traps, which are accessible and currently under considerable scrutiny, may be better explained by a large impact than by a conventional mantle plume. The closure of a former ocean between Siberia and Mongolia, as well as amalgamation with north and south China blocks may also have been occurring during Permian-Triassic times. ( → These events were the result of the P/T-Impact Event !! → comment from Harry.K.Hahn )

Page 97 : Decompression melting must be seriously considered whenever an impact is sufficiently large to cause the transient crater depth to excavate a substantial fraction of the local crustal thickness, and thereby cause a sudden drop in lithostatic pressure beneath the crater.

**Another study which indicates a Permian-Triassic Impact Event in Australia** : [Raining lead around 250 mya : A smoking gun for an Australian impact origin of the Permian Extinction](#) ; by Jim Standard & C. Austen Angell , Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ 85287

see Study :

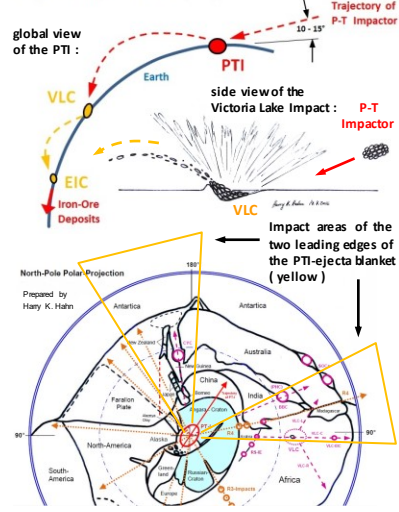
[End-Permian catastrophe by bolide impact: Evidence of a gigantic release of sulfur from the mantle](#)

by Kunio Kaiho, Y.Kajiwara, Yasunori Miura

# The result of the PT-Impact: The Pacific - LLSVP and the African - LLSVP were caused by the two main Ejecta Rays of the PTI

There is strong indication that the **Permian-Triassic Impact (PT-I)** and the ejecta rays which were caused by this enormous impact are responsible for the formation of the two main **LLSVPs** ( **Large low-shear-velocity provinces** ) inside Earth's mantle. These two large structures, which are characterized by slow (seismic) shear wave velocities and which consist of much hotter material (~4000°K) than the surrounding mantle material (~2000°K), extend laterally and vertically for thousands of kilometers from the core-mantle boundary. In all probability the remains of large secondary impactors and the powerful ejecta of the leading edges of the two ejecta-wings of the PT-I descended deep into Earth's Mantle and caused the **LLSVP's** as a result.

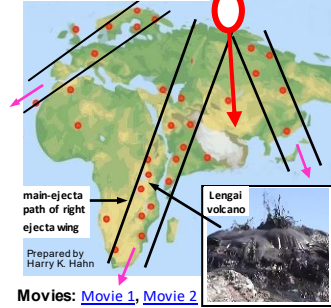
## Impact Scenario of Victoria Lake Crater (VLC) & Ejecta Impact Crater (EIC):



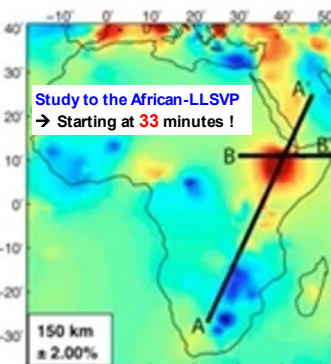
The diagram on the left shows the shallow (oblique) impact of the PT-Impactor which probably had a diameter of around ~60 to 200 km. It also shows a side view of the **Victoria Lake Impact** (crater) (→ **VLC**) which was caused by a large secondary impactor ejected from the PTI-crater. Part of the ejecta from the VLC was ejected forward in impact direction where it formed another secondary crater, the EIC. The rest (the majority) of the VLC-ejecta was again ejected in a butterfly-ejecta-pattern. Traces of "forward-ejecta", which always seems to be dense & ductile metal-bearing material, are also visible near the CYC- and PHC (BBC)-craters. The majority of the ejecta from the PTI-crater was ejected in the form of a gigantic butterfly-shaped ejecta blanket. Where the leading edges of the two ejecta wings of this butterfly-ejecta blanket impacted on Earth's crust (in the yellow marked areas) extensive fractures (new continent borders) were formed. The north-polar-projection of Earth, shown on the left shows Earth at PT boundary time

A large part of the ejected material and a number of big secondary impactors impacted in these two yellow marked areas. → see also larger map in the chapter: "Earth at the time of the PT-impact Event" The world map on the left shows the distribution of **Carbonatites** in Africa & Eurasia. I have rearranged the position & orientation of Africa, Europe and India so as they were just after the PT-Impact 253 Ma ago (→ original map, Le Bas 1987). **It is clearly visible that the carbonatites are mainly located along the paths where the leading edges of the ejecta wings of the PTI impacted!!** This is especially clear for the impact path of the leading edge of the right ejecta wing along the east-coast of Africa (→ ejecta ray R4 & VLC-ray). Because the **Carbonatites** are probably derived from Earth's lower mantle, we can conclude that the shock-wave of the PTI-impact, or PTI-ejecta descending into the mantle, brought carbonatites from the lower mantle to the surface, or the carbonatites were brought-in by the impactor itself! Lengai Volcano in Tanzania still erupts Carbonatite-Lava today! (→ from the African LLSVP!)

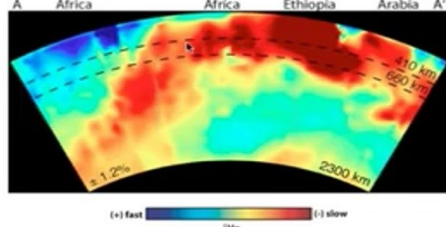
## Carbonatite distribution along main-ejecta paths of the PT-I: PT-I crater



Movies: [Movie 1](#), [Movie 2](#)  
see: [Study about Carbonatite Lava](#)



**Study to the African-LLSVP**  
→ Starting at 33 minutes!



The two images on the bottom left side show a section view of the **African-LLSVP**. The section view A – A' runs from the Arabian Peninsula through the **African Rift Valley** and the **Victoria Lake (VLC)** area towards South-Africa. The section view runs essentially along the same path where the leading edge of the right ejecta wing of the PTI impacted. It is clearly visible that the main structure of the African **LLSVP** is orientated along the same path as the impacting right leading edge of the PTI-ejecta. (→ LLSVP = red, orange & yellow area in the section view A – A'). The images are from a study of Andy Nyblade which used **African-Array Data**. He claims that evidences indicate that the African LLSVP is a thermochemical **whole-mantle-structure** without a separation in the 410-660 km region.

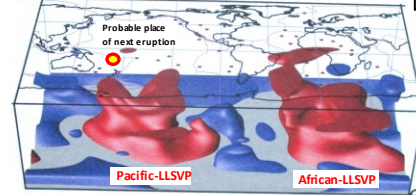
The same principles applies for the **Pacific LLSVP**. The two maps on the top right side show that especially the **ULVZ** at the **core mantle boundary (CMB)** within the Pacific LLSVP is mainly orientated along the path where the leading edge of the left ejecta wing of the PTI impacted. Because this ULVZ has a distinct chemical signature there is a high probability that the **ULVZ** is a direct result of ejecta of the PTI which descended to the CMB in this area.

**Note:** it seems that the Cape York Impact produced a permanent channel in the mantle which connects the Pacific-LLSVP/ULVZ with the surface. Through this channel in the mantle ≥8 violent magma eruptions occurred over the last ~200 Ma causing a number of big **LIP's** on the Pacific Plate (e.g. the **Ontong LIP**)

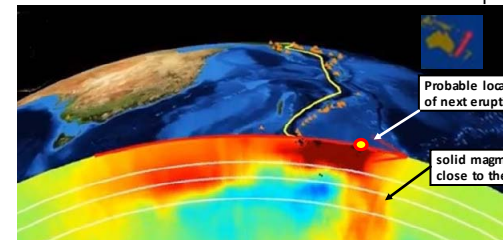
**Warning:** There is a high probability that another such violent magma eruption will occur!! My study indicates that the next magma eruption will take place near the **Fiji-islands** → see image on the right which shows the path of the source (outflow channel positions = yellow dots) of the magma eruptions. It seems the Pacific LLSVP is due for an eruption soon! The solid upward pointing column at the top-end of the LLSVP, near the **Fiji's** may indicate the coming eruption (& **mass extinction**!). The vertical expansion rate of this column must be measured!!!

**Note:** All volcanos of the **Pacific Fire Ring** and all other volcanos on Earth can be explained by the Permian-Triassic Impact! They are all located in the (fractured)crust areas which were directly caused by the ejecta of the PT-I!! The magma (molten mantle material) which causes these volcanos, in all probability is **exclusively** a result of the impact of ejecta & secondary impactors from the PTI!!! Therefore a revised model for **Earth's mantle** is required, which must consider a much higher share of **volatiles**, e.g. H<sub>2</sub>O & CO<sub>2</sub> within the mantle material

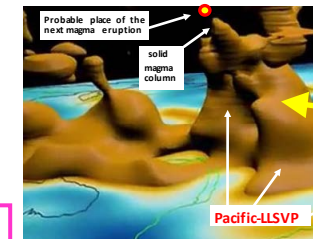
## (D) Shear velocity heterogeneity



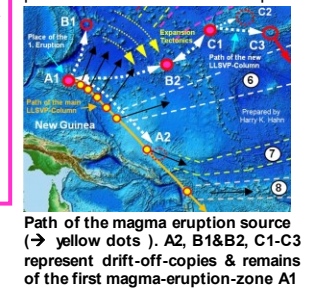
A 3-D view of the Pacific- & African LLSVP and the probable location of the next eruption



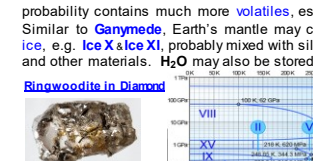
3D-Model No. 1 of Pacific LLSVP → see: [3D-Animation 1](#)  
3D-Model No. 2 of Pacific LLSVP → see: [3D-Animation 2](#)



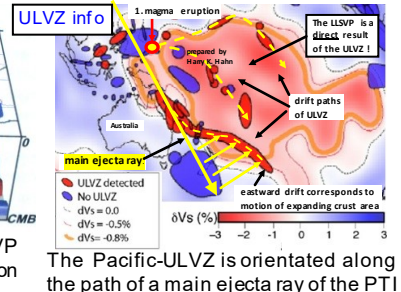
3D-view of Pacific-LLSVP with the possible location of next eruption



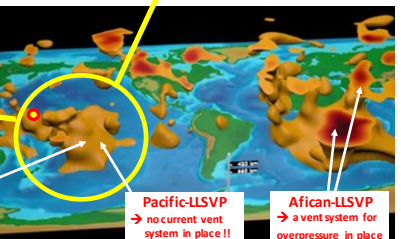
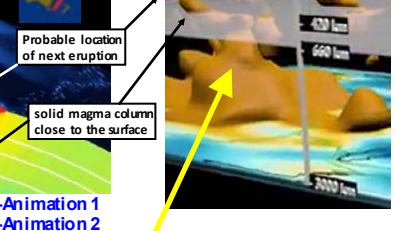
Path of the magma eruption source (→ yellow dots). A2, B1&B2, C1-C3 represent drift-off-copies & remains of the first magma-eruption-zone A1



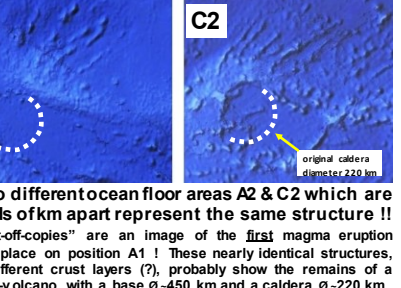
An alternative model for Earth's mantle is required!! Earth's mantle in all probability contains much more **volatiles**, especially H<sub>2</sub>O, than currently believed!! Similar to **Ganymede**, Earth's mantle may contain a high share of **high-pressure ice**, e.g. **Ice X & Ice XI**, probably mixed with silicate material like in **Callisto's** mantle and other materials. H<sub>2</sub>O may also be stored in materials like **Ringwoodite** etc.



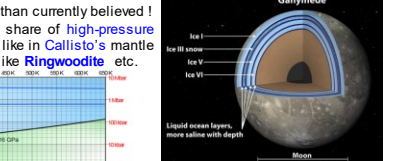
The Pacific-ULVZ is orientated along the path of a main ejecta ray of the PTI



This 3-D Animation shows the African-LLSVP has a large vent system for overpressure in place, but the Pacific-LLSVP doesn't!



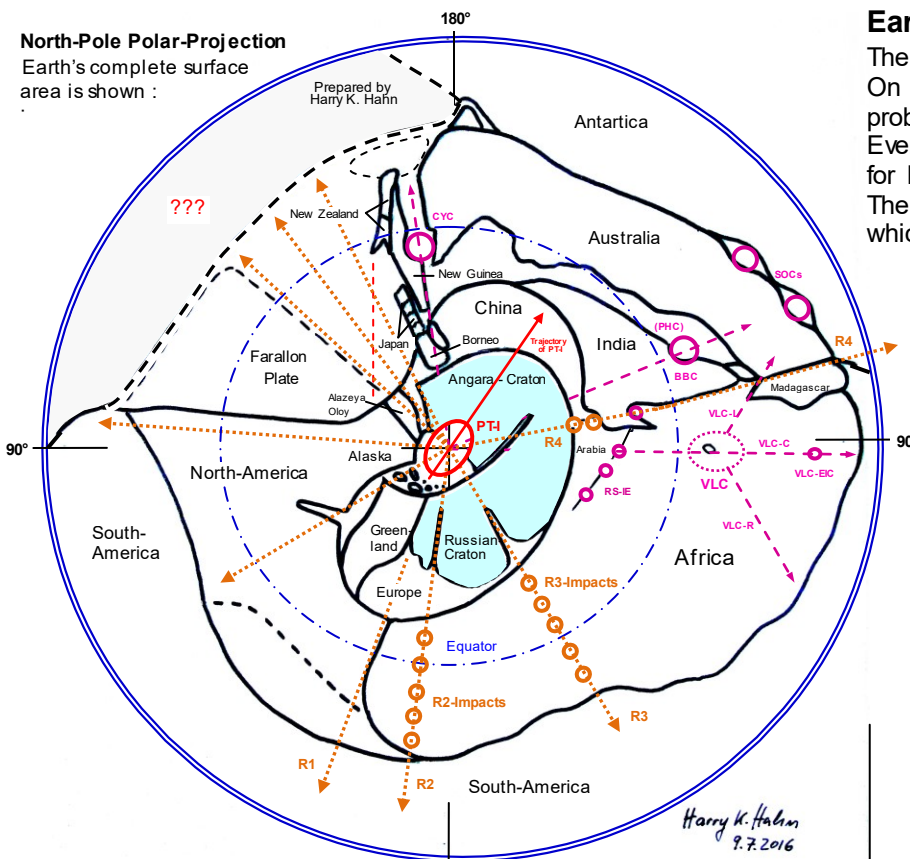
These two different ocean floor areas A2 & C2 which are thousands of km apart represent the same structure!! These "drift-off-copies" are an image of the first magma eruption which took place on position A1! These nearly identical structures, from two different crust layers (?), probably show the remains of a burst shield volcano with a base ø-450 km and a caldera ø-220 km.



An alternative model for Earth's mantle is required!! Earth's mantle in all probability contains much more **volatiles**, especially H<sub>2</sub>O, than currently believed!! Similar to **Ganymede**, Earth's mantle may contain a high share of **high-pressure ice**, e.g. **Ice X & Ice XI**, probably mixed with silicate material like in **Callisto's** mantle and other materials. H<sub>2</sub>O may also be stored in materials like **Ringwoodite** etc.

**North-Pole Polar-Projection**

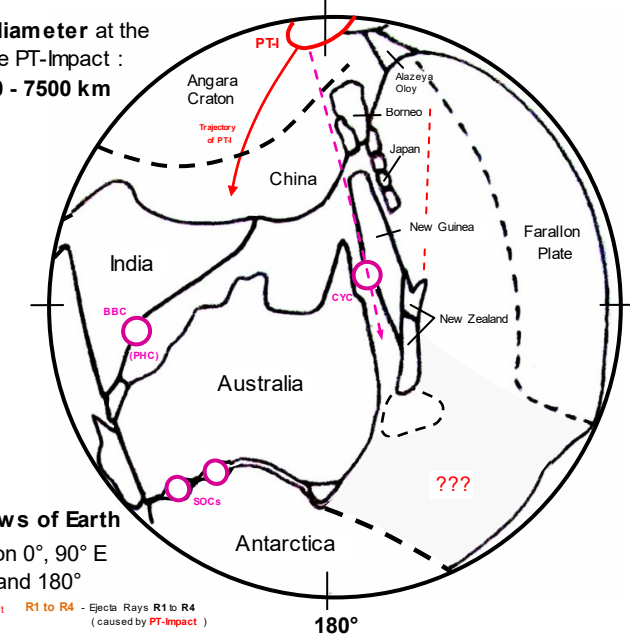
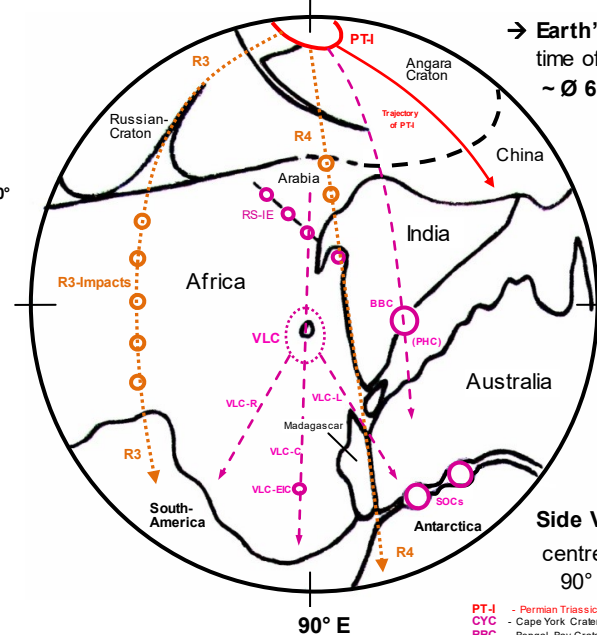
Earth's complete surface area is shown :



**Earth at the time of the PT-Impact Event (with all PT-secondary craters shown)**

Prepared by Harry K. Hahn

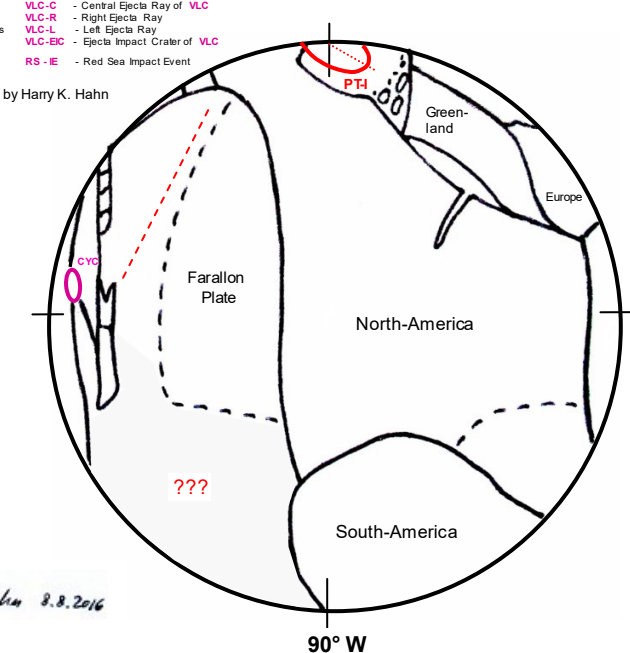
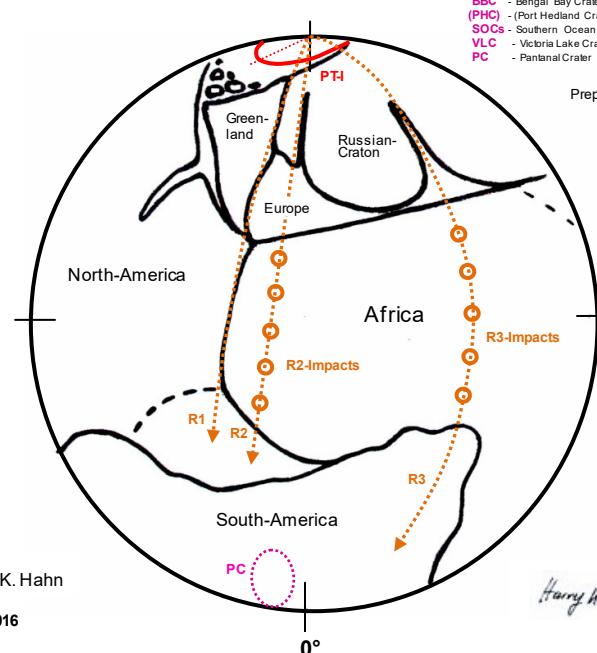
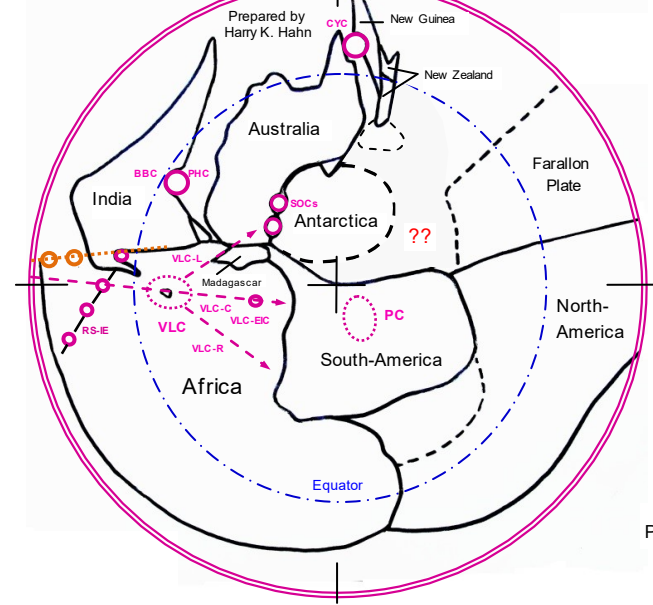
The following maps show how our planet Earth probably looked at the time of the Permian-Triassic (PT)-Impact. On these maps, the arrangement of Earth's continents at PTI-time is based on impact structures which in all probability were caused by the PT-Impact Event (especially the CYC-, the BBC / PHC- and the VLC-Impact Event and the Ejecta Rays (crater chains) R1-R4 were used as a reference). And an [Expansion Tectonics](#) model for Earth was used as base for these maps. The PT-Impact Event caused the shown fracture pattern on Earth. The leading-edges of the two ejecta-wings, cut through Earth's crust (along R4 and along the CYC-chain) which caused the African- & Pacific-LLSVP and triggered an expansion (tectonics) process in Earth's mantle.



**Side Views of Earth**  
centred on 0°, 90° E  
90° W and 180°

- PT-I - Permian Triassic Impact
- CYC - Cape York Crater
- BBC - Bengal Bay Crater
- (PHC) - (Port Hedland Crater)
- SOCs - Southern Ocean Craters
- VLC - Victoria Lake Crater
- PC - Pantanal Crater
- R1 to R4 - Ejecta Rays R1 to R4 (caused by PT-Impact)
- VLC-C - Central Ejecta Ray of VLC
- VLC-R - Right Ejecta Ray
- VLC-L - Left Ejecta Ray
- VLC-EC - Ejecta Impact Crater of VLC
- RS-IE - Red Sea Impact Event

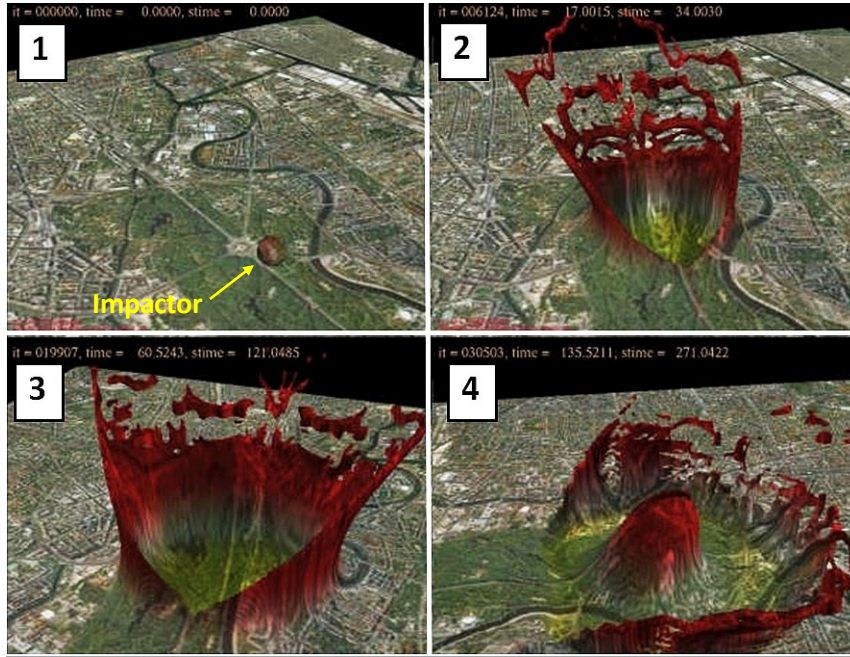
**Polar-Projection of South-Pole area**  
up to ~ 45° northern latitude :



Prepared by Harry K. Hahn  
Update : 9-10-2016

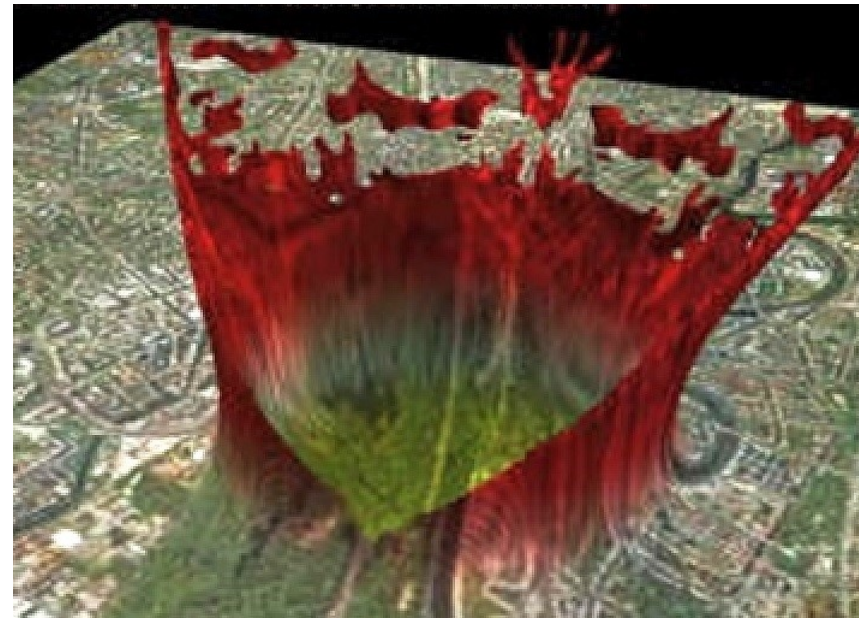
Harry K. Hahn 9.9.2016

# The impact of the leading edges of the two Ejecta-wings of the PT-impact caused the Pacific-LLSVP and the African-LLSVP



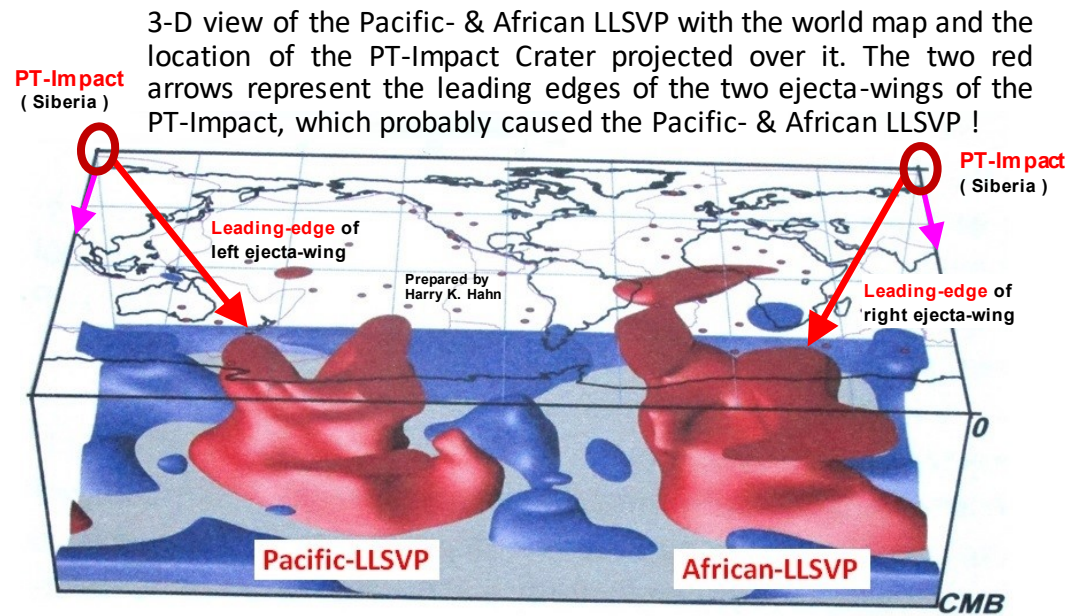
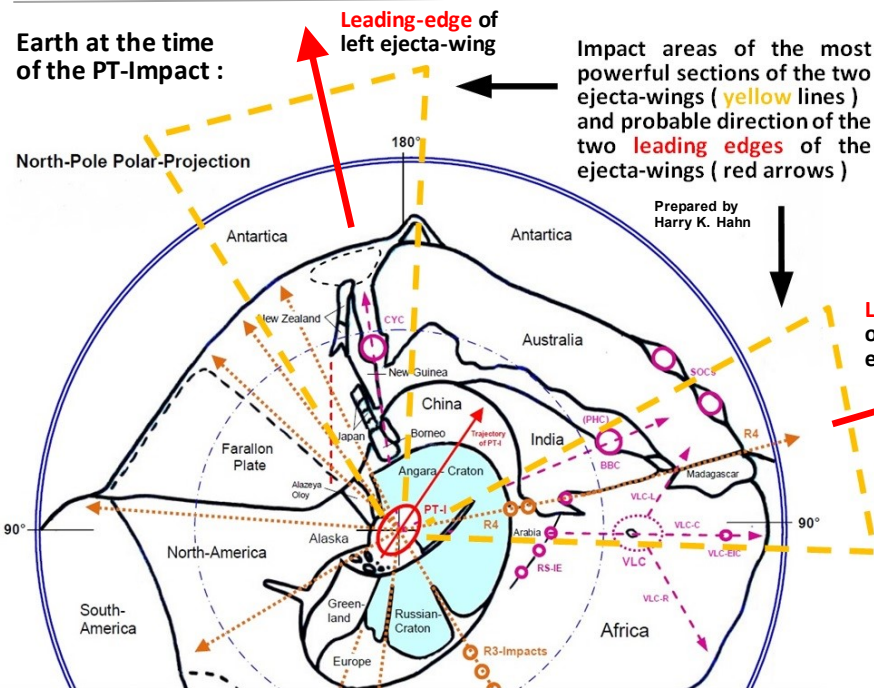
This image sequence 1-4 shows a shallow (oblique) impact of a meteorite. Because the impactor hits the surface in a shallow angle two ejecta-wings are caused by the impact. (computer simulation of such an impact event)

The Permian Triassic (PT) Impact has caused two ejecta-wings (or-blankets) with powerful leading-edges of these ejecta-wings which cut through Earth's crust when they impacted on the surface. The ejecta material that has formed these leading-edges then descended into Earth's mantle where it caused the African- and Pacific-LLSVP, the two major LLSVPs. **Leading-edge of the left ejecta-wing**



**Leading-edge of the right ejecta-wing**

Magma (molten mantle material) in Earth's mantle probably is the result of ejecta material from the PT-impact, which descended into Earth's mantle in the major fracture zones, caused by the leading edges of the PT-ejecta-wings. All volcanos of the Pacific Fire Ring and volcanism on Earth can be explained by the Permian-Triassic Impact! Therefore a revised model for Earth's mantle is required, which must consider a mantle consisting of a mixture of silicate minerals and high-pressure ice, e.g. **Ice X** & **Ice XI** with a density  $\geq 3$ , which goes through a phase change because of the LLSVP-areas and expands Earth's mantle!



**Quartz-samples from potential Secondary-Impact-Craters & -structures caused by the Ø 1270 x 950 km PT-Crater, which indicate an Impact-shock event :**

→ For more detailed information please read [Part 6](#) ( or [here](#) ) of my study, and follow the links to the Raman-analyses or go to my website :

→ [Geological Evidence](#)  
( or alternative : [here](#) )

**Note :** The main-Raman-peaks of  $\alpha$ -Quartz ( unshocked quartz ) have the wave-numbers : **464, 264, 206** and **128 cm<sup>-1</sup>**

→ A shift of  $\geq 1 - 2 \text{ cm}^{-1}$  of the main-Raman peaks, indicates that the quartz was shocked with an impact-shock-pressure of  $\geq 20 \text{ GPa}$

Impact-Crater or -structure	Sample-Site area	Sample-Site No.	Sample	Spectral-Line Position in cm <sup>-1</sup>			
				Main Quarz-Spectral-Lines			
Ø 130 x 110 km Bay-of-Lyon Crater ( France/Spain )	crater-wall-area	27-B	stone 3	463	261	205	125
		27-B	stone 6	461			125
Ø 30 km Impact Structure (Spain)	crater-wall	50	stone 1	463	261	205	127
Ø 1,6 x 1,2 km Impact Crater (Spain)	crater-center	40-B	stone 1	463	261/263	203	127
PTI-Ejecta-Ray 1 Structures (Spain)		6-A	stone 1	463	261	204	126
Ø 160 km Salerno Impact Crater ( Italy )	crater-wall-area	21	stone 1		261	204	125
		21	stone 2		260	205	
Ø 320 km Cape York Crater (NE-Australia)	just outside of crater-wall	46-C	stone 1	463	261	203	126
Ø 40 x 33 km elliptical Impact Crater (NW-Australia / Pilbara)	crater-center & ejecta-structures	25	stone 2	463	261	205	125
		11	stone 2	463	260	204	126
		10	stone 2	463			126
Ø 30 km Mt Warning Impact Crater ( East-Australia )	crater-wall-area	8-B2	stone 3	463	260	205	127
		8-B3	stone 1		263	205	
Ø 8 x 7 km elliptical Warwick Crater (E-Australia)	crater-center-area	43	stone 1	463		204	
		53	stone 1		263	204	
PTI-Ejecta-Ray-4 impact-Structures (West-Australia) in the Margaret River area ( on the western border of the Australian Plate )	Ejecta-impact-structures	5-B	stone 1	463	258/264	205	126
		2	stone 1			204	125
		7-B	stone 1		263		126
Ejecta-Ray Structure of the Ø 420 km SOC-Crater ( SOC = Southern Ocean Crater / SW-Australia )	Ejecta-impact-structures	55	stone 1		263	205	
		50	stone 2			204	124
Ejecta-Ray Structures in the Kalgoorlie-area (W-Australia) caused either by the PHC or VLC ( PHC=Port Hedland Crater; VLC=Victoria Lake Crater ) <b>Note :</b> the Super-Pit gold-mine in Kalgoorlie is one of the largest gold-mines in the world. Other rare- and heavy-elements are present in this area	Ejecta-impact-structures	2	stone 1	462	261	204	125
		2	stone 2	463	260	205	
		4	stone 1	463	260	204	
		5	stone 1	463	260/266		
		21	stone 1	463	261		125
		27	stone 1	463	261	205	125
		31	stone 1	463	257/267	204	125
13	stone 1			204	126		
Ejecta-Ray Structures in the Southern-Cross-area caused either by the PHC or VLC ( PHC=Port Hedland Crater; VLC=Victoria Lake Crater )	Ejecta-impact-structures	1	stone 1	463	261	204	126
		9	stone 1	463	261	205	
		16	stone 1	463	261	205	
Ejecta-Ray Structures in the Geraldton-area (W-Australia) caused either by the PHC or VLC ( PHC=Port Hedland Crater; VLC=Victoria Lake Crater )	Ejecta-impact-structures	11	stone 2	461			126
		17	stone 1	463	262/268		125
		12	stone 2		261		126

GPS - datas					
Latitude			Longitude		
42°	19,276	N	3°	19,028	E
37°	31,508	N	1°	28,925	W
36°	49,823	N	2°	5,035	W
39°	42,036	N	2°	33,932	E
40°	7,67	N	15°	14,621	E
14°	48,875	S	144°	57,644	E
20°	33,374	S	118°	42,786	E
20°	21,904	S	119°	27,818	E
20°	19,691	S	119°	27,394	E
28°	30,971	S	153°	12,48	E
28°	30,972	S	153°	12,483	E
28°	11,288	S	151°	45,418	E
28°	14,335	S	151°	47,524	E
33°	52,745	S	114°	58,89	E
33°	33,575	S	115°	0,365	E
34°	22,507	S	115°	8,101	E
32°	7,457	S	123°	10,561	E
32°	0,712	S	122°	47,863	E
30°	54,591	S	121°	12,552	E
30°	55,361	S	121°	11,702	E
30°	55,529	S	121°	11,523	E
30°	50,865	S	121°	30,069	E
31°	8,356	S	121°	37,714	E
31°	11,047	S	121°	38,736	E
30°	52,004	S	121°	13,039	E
31°	2,082	S	119°	9,223	E
30°	47,582	S	118°	59,288	E
30°	46,712	S	118°	56,13	E
29°	13,227	S	116°	20,477	E
29°	11,412	S	116°	14,237	E
29°	13,253	S	116°	19,932	E

**Please note :**

The listed samples sites (→ see GPS-datas) are from impact-craters and impact-structures which are still unknown to the geological society !

These sites represent secondary impact-craters and impact-structures of the PT-Impact Event.



# → Evidence of shock-metamorphic effects from ≥ six possible Secondary Craters of the PT - Impact Event :

## 1.) The ≈ Ø 130 x 110 km "Bay of Lyon Crater" in France :

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from sample site **27-B**

→ **Raman spectra of rock samples from the Bay-of-Lyon Crater** ( or → [here](#) )

Photos of the Sample Sites & Rock Samples ( No. 27-B3 (1-4)) are available here : ► **Sample Sites "Bay of Lyon Crater"**

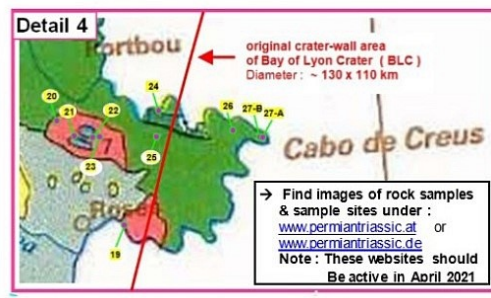
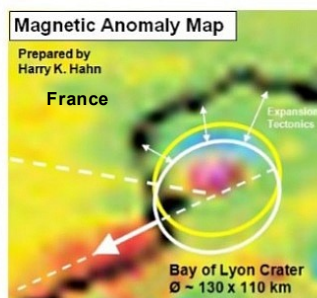
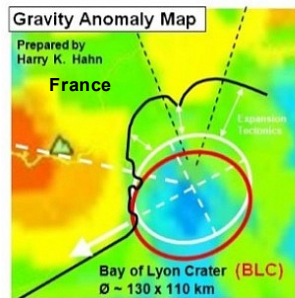
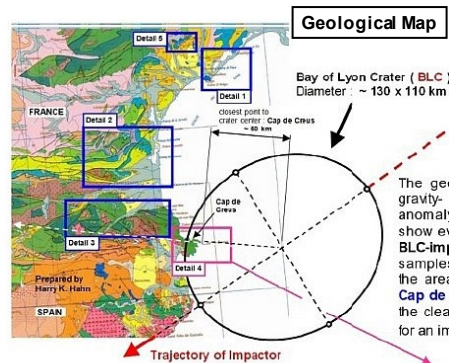
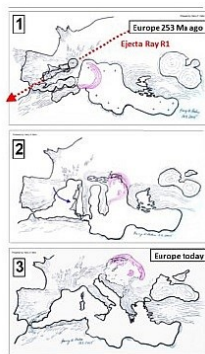
The Ø 130 x 110 km Bay of Lyon Crater is the first member of a secondary impact crater chain which formed the coastline of Eastern-Spain and the western coastline of Italy. ( → see description in my PT-impact hypothesis ) It was the first and probably most powerful crater at the northern end of this secondary crater chain, and it represents approximately the pivot-point, around which the Italian mainland and the Yugoslavian Block, rotated after the PT-impact Event (see image sequence 1-3 below). **Raman spectra of quartz** grains from **sample site 27-B** clearly indicate a shock-event caused by an impact which has formed "Cabo de Creus" (site 27-B). **This is a first strong indication for the existence of the Ø 130x110km "Bay of Lyon" Crater**

The possible impact crater is noticeable on a gravity anomaly map and the crater-center has left a strong signature on the magnetic anomaly map too, which indicates that the impactor ( a big ejecta fragment from the PT-Crater ) probably consisted of a considerable amount of iron.

The closest point on land in reference to the assumed crater center of the "Bay of Lyon Crater" is **Cabo de Creus** in Spain. Here sample location **27-B** is located. The rock-type (46) marked in dark green on the geological map is ≈ 440-550 Ma old (Paleozoic Age) and therefore contains shock-metamorphic effects of the PTI-event, in this case from the "Bay of Lyon Crater". Sample site 27-B shows a large area which consists of rock that was partly melted and strongly deformed. In all probability all the rock on this site is partly melted ejecta from the Bay of Lyon Crater, and some of the rocks may be ejecta from the PT-impact Crater as well. Cabo de Creus may represent a small remaining section of the original crater-wall of the "Bay of Lyon Crater"

### → Geological Map of Spain :

<http://www.zonu.com/fullsize-en/2010-09-01-12020/Geological-map-of-Spain-1994.html>



The above shown Cap de Creus is the closest point to the center of impact of the Bay of Lyon Crater (BLC). Distance to the crater center ≈ 50 km  
It seems that Cap de Creus is a remain of the original crater-wall of the Bay of Lyon Crater ! Therefore it should be a primary research area for the scientific analysis of this impact Event.

→ Find images of rock samples & sample sites under :  
[www.permantriassic.at](http://www.permantriassic.at) or  
[www.permantriassic.de](http://www.permantriassic.de)  
Note : These websites should Be active in April 2021

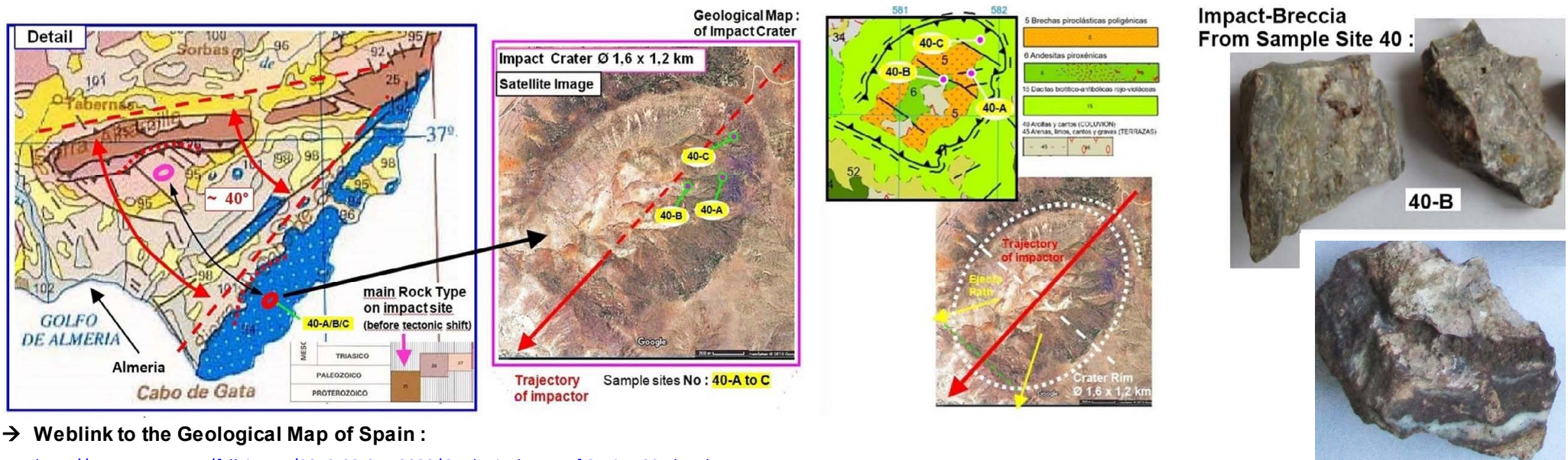
## 2.) The Ø 1.6 x 1.2 km elliptical Impact Crater in Southern-Spain ( ≈ 35 km East of Almeria ) :

- Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from Sample Site **40-B**
- **Raman spectra of samples from the 30 km & 1.6x1.2 km Craters** ( or [here](#) )

Photos of the Sample Sites & Rock Samples ( No. 40-B and others ) are available here : ► [Sample Sites - Spain\\_3](#)

At the center of this elliptical Impact Crater shock-metamorphed rock ( Impact-Breccia ) crops out of the ground. This certainly isn't a volcanic structure ! It is a perfect Ø 1.6 x 1.2 km "oblique impact crater", but unknown to the geological society ! **Raman spectra of quartz from sample site 40-B point towards a shock-event caused by an Impact.** The spectra indicate that the quartz was exposed to an impact shock pressure of around 22 GPa. **This elliptical Impact Crater is very interesting because it has the potential to proof the large-scale impact-scenario in Southern-Spain, which in all probability was caused by the PT-Impact Event.** And it can proof the tectonic-shift and rotation of a large area consisting of Proterozoic Rock ( > 250 Ma old ) which in all probability was caused by the tectonic motion of the African Plate, that was triggered by impacting ejecta of the PT-Crater. Please note that the crater originally impacted in the "brown-colored" rock-type 25, which is Proterozoic Rock ! ( see Geological Map below ! ) This is indicated by the curved cutout ( or dent ) visible in the brown rock-type ( see map below ), which represents a linear 300 - 400 m high mountain range. I have drawn-in a small pink-colored ellipse on the position where I believe the crater was originally located in reference to this mountain range. This mountain range consisting of rock-type 25 in all probability is the remaining section of an ejecta ray from the PT-Crater, and the small elliptical crater was caused by a larger fragment from the ejecta of the PT-Crater. The blue-colored rock type is much younger and was produced by the volcanic activity which was triggered by the large-scale impact event.

The orientation, ellipticity and shape of the impact crater, which is perfectly orientated in line with the mountain range, provide precise information about the trajectory, impact angle and velocity of the ejecta from the PT-Crater that impacted here. Therefore this secondary-crater of the PT-Impact Event should be an important study object in order to bring light in the large-scale impact scenario caused by the PTI which took place in Europe ≈ 253 Ma ago



→ Weblink to the Geological Map of Spain :

<http://www.zonu.com/fullsize-en/2010-09-01-12020/Geological-map-of-Spain-1994.html>

### 3a.) The $\approx \varnothing$ 30 km Impact Structure in Southern-Spain (near Puerto de Mazarron in Murcia in Andalucia) :

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from the Sample Sites 50 and 19-B & 30-B  
→ Raman spectra of samples from the 30 km & 1.6x1.2 km Craters ( or → here )

Photos of these Sample Sites & Rock Samples (and others) are available here : ► **Sample Sites - Spain\_3** & **Sample Sites -Spain\_1 & 2**

The  $\approx \varnothing$  30 km bow-shaped Structure which is visible on the satellite image ( → see image below ) was caused by an Impact Event. **Shocked quartz** that was found on **sample site 50** clearly indicates that the quartz was exposed to a **shock pressure of around 22 GPa**. ( → see Raman spectra on the next pages )

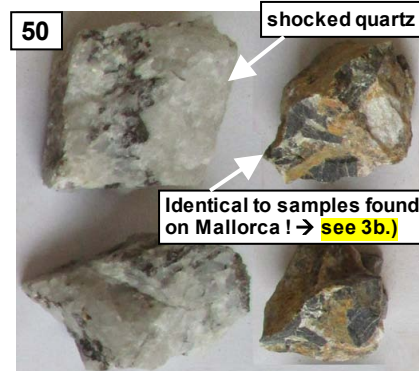
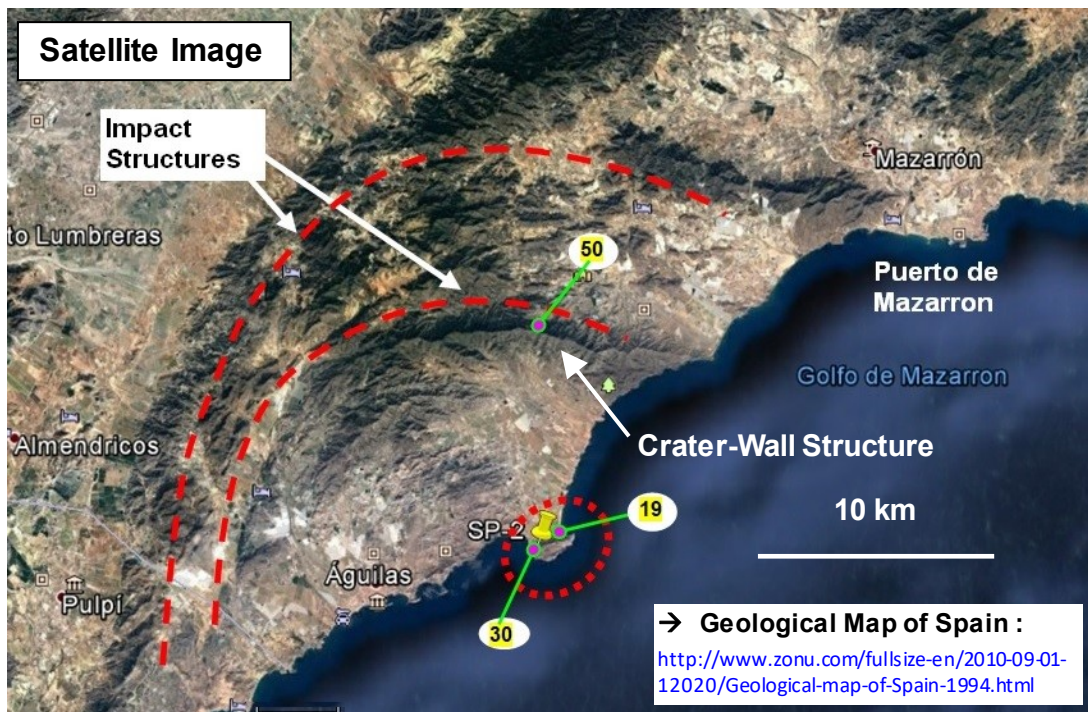
This large bow-shaped Impact Structure belongs to a large-scale impact event which according to my hypothesis was caused by ejecta material that was ejected from the Permian Triassic (PT) Crater in the Arctic Sea ( see Parts 1 to 5 of my hypothesis ).

The impact structure belongs to a large-scale Secondary Crater Chain that was caused by the PT-Impact Event. The “Bay-of-Lyon Crater“ described under 1.) and the  $\varnothing$  1.6 x 1.2 km "oblique impact crater" described under 2.) are impact craters which belong to the same Secondary Crater Chain ( → PT-Impact Event )

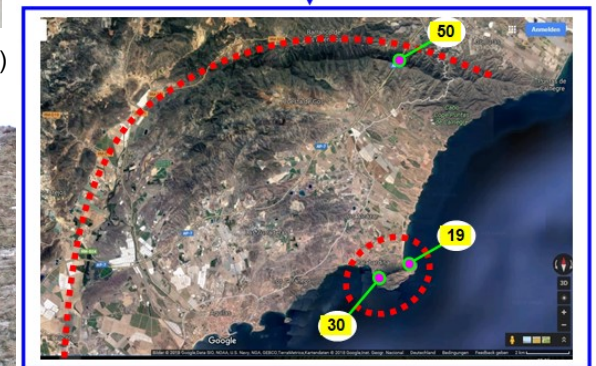
The Geological Map of Spain shows that the bow-shaped “Crater-Wall structure” consists of rock-type 25 ( brown-colored on the geological map ), which is Proterozoic Rock that probably is > 250 Ma ( million years ) old !

The age of the rock at sample site 50 also indicates that the impact structure can be a result of the PT-Impact Scenario described in my hypothesis.

Rock samples collected at the sample sites 19 and 30, at the center of the bow-shaped impact structure (Cabo Cope), also indicate a impact shock event. Quartz in these rock samples shows similar ( but slightly weaker ) shifts of the main Raman peaks, as the shocked quartz collected on sample site 50.



Sample Site 50 ( at AP7 tunnel exit )



### 3b.) Traces of the Permian-Triassic Impact Event found on the islands Mallorca (Spain) and Sardinia (Italy) :

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from the Sample Sites 6-A & 6-B on Mallorca

Photos of these Sample Sites & Rock Samples and Raman spectra of analysed rock samples are available here :

► **Traces of the PT- Impact Event found on the Islands Mallorca & Sardinia, with Raman spectra of selected Rock Samples** ( or : [here](#) )

Just a few kilometers offshore of the eastern coast-line of **Mallorca** there is a distinct linear step visible on the ocean-floor topography.

This linear step on the ocean-floor represents a linear fracture in Earth's crust that was caused by the impact impulse of ejecta-material, which was ejected by the **Ø 1270 x 950 km Permian-Triassic Impact Crater (PTI)** along the **PTI-Ejecta Ray R1**.

Parallel to the mentioned linear step on the ocean-floor, more such linear fractures were caused by the impact of Ejecta Ray R1, along the western side of Mallorca ( e.g. in the Tramuntana Range ). These linear fractures and the impulse of the impacting PTI-ejecta-material have caused small crust-fragments which were inclined towards east. On their western side these crust-fragments were lifted upwards by the impact event, and in this way they formed the linear mountain range "**Serra de Tramuntana**" on the island Mallorca, which runs all along the west-side of Mallorca in NE to SW direction.

The mentioned linear fractures are the cause for the later break-off of the three islands **Mallorca**, **Menorca** & **Ibiza** from the spanish mainland. One particular deep fracture, in combination with the expansion- tectonics process which was triggered by the PT-Impact Event, has caused this "break-off"-process.

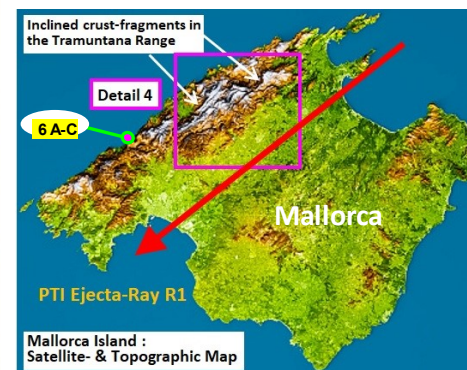
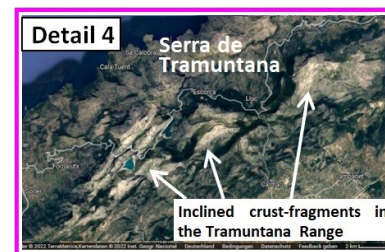
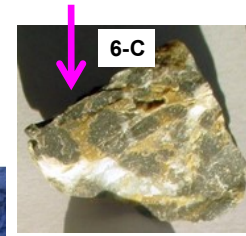
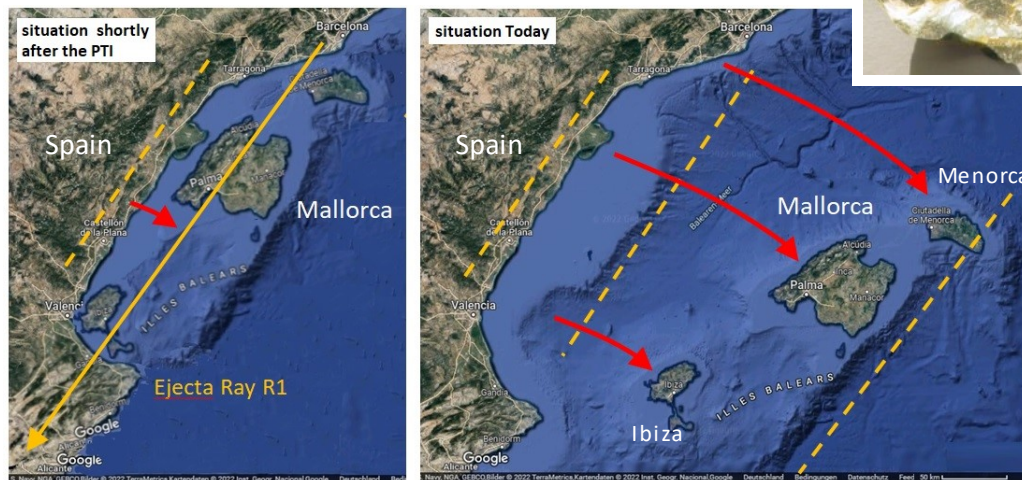
I also found **additional traces of the PT-Ejecta-Ray R1** and a **small impact crater** on satellite images of the island **Sardinia** ( see image below on the right )

In the **Raman Spectra of quartz grains** from rock samples collected at the **sample sites 6-A and 6-B** on the north-coast of the Tramuntana Range there are **clear shifts of the main Raman bands ( peaks ) to the lower frequencies 463, 261, 204 and 126  $\text{cm}^{-1}$**  visible in the spectra, which **indicate** that the quartz was exposed to a **shock pressure of  $\approx 20 - 22 \text{ GPa}$** . Note that **Breccia-samples from site 6-C** are identical to Breccia-samples which I have collected

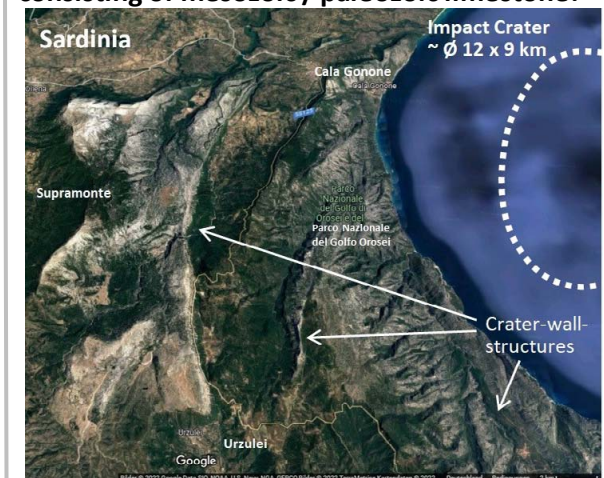
**near the Ø 30 km Impact Structure in Southern-Spain 3a) !**

( → see Sample Site [50](#) ( → Ø 30 km impact structure )

The islands Mallorca, Menorca & Ibiza were cut-off from the mainland of Spain by the Ejecta Ray R1 ( from the PTI )



There is a secondary impact crater Ø 12 x 9 km visible on the island Sardinia, caused by the Ejecta Ray R1. The crater-walls (-structures) consisting of mesozoic / paleozoic limestone.



#### 4.) The $\approx \varnothing$ 160 km "Salerno Crater" in Italy :

→ Shock-metamorphic effects of the Impact : Indication for **Shocked quartz** was found in rock samples of Sample Sites **20 & 21**  
 → **Raman spectra of rock samples from the Salerno Crater** ( or → [here](#) )

Photos of these Sample Sites & Rock Samples ( and other sample sites ) are available here : ► **Sample Sites "Salerno Crater"**

The  $\varnothing$  160 km "Salerno Crater is part of the same secondary crater chain as the "Bay of Lyon Crater" described under 1.) , which in all probability was caused by ejecta that was ejected from the Permian Triassic Crater  $\varnothing$  1270 x 950 km Permian Triassic Impact Crater (PTI) in the Arctic Sea near Alaska This secondary crater chain probably consisted of at least four major secondary craters. ( → see image sequence 1 to 3 below )

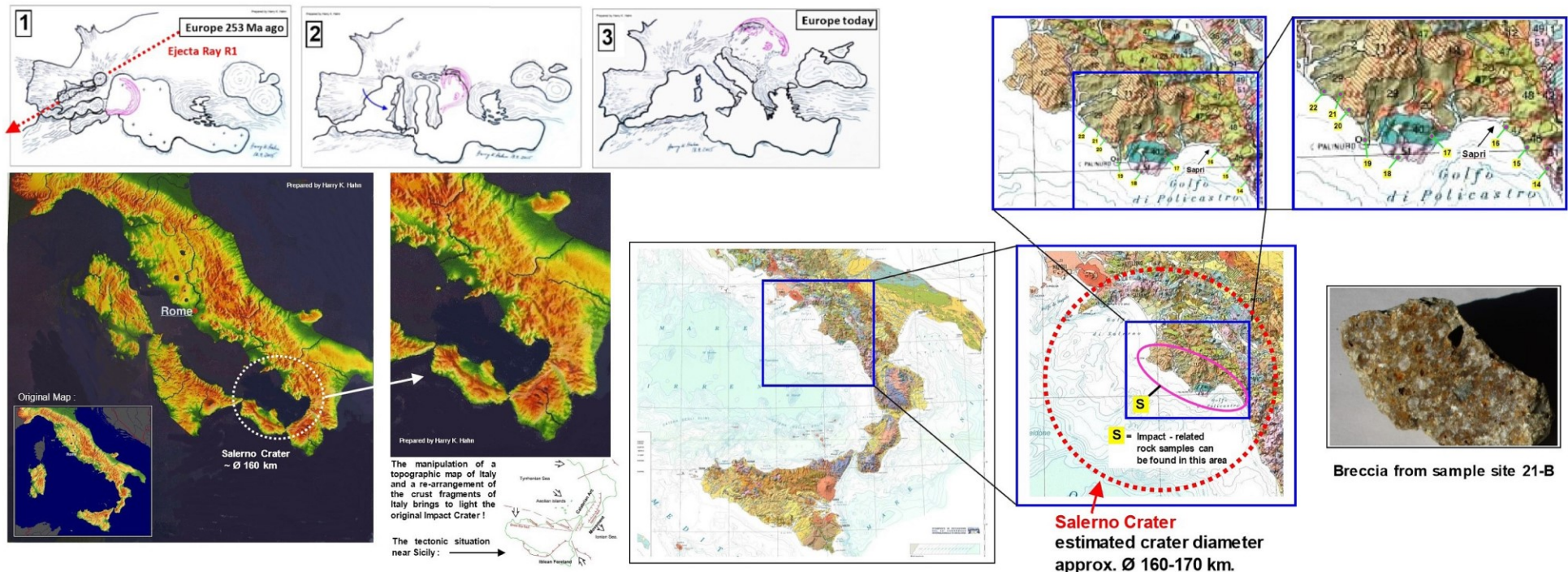
The first crater of this crater chain is the "Bay of Lyon Crater" ( → probably the most powerful crater ) and the last crater was the "Salerno Crater" which is still noticeable on the topography map of Italy, if the crust fragments which form Italy are arranged in their positions as they were approx. 200 Ma ago.

In the **Raman Spectra of quartz grains** from rock samples collected at the **sample sites 20 & 21** there are shifts of main Raman bands ( peaks ) to the lower frequencies noticeable in the spectra, which indicate that the quartz was exposed to a **shock pressure of  $\approx$  20 - 22 GPa**.

But these shifts of the main Raman peaks are less pronounced than the peak shifts in the samples of the "Bay of Lyon Crater" (BLC). This indicates that the impact pressure or shock pressure was less at the end of the described crater chain than at the start of the chain ( at the BLC ).

**Microscope images** of some of the analysed quartz grains in samples from the **sites 21 & 20** also seem to indicate an impact shock event.

In order to confirm the Salerno Crater as a secondary crater of the PT-Impact Event an analysis for PDFs ( planar deformation features) should be done.



→ **Geological Map 1:250000** → other geological maps → raster selection 1:100000

**Salerno Crater**  
 estimated crater diameter  
 approx.  $\varnothing$  160-170 km.

## 5.) The $\approx \emptyset$ 320 km "Cape York Crater" in North-East Australia :

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from the Sample Sites **46 & 50** (2.trip)

The sample site **49-C / 23** ( 1. & 2.trip) also indicates an impact event → **Raman spectra of rock samples from the Cape York Crater** (or [here](#))

Photos of Sample Sites & Rock Samples are available here : ▶ **Sample Sites CY-Crater 2** (2.trip) & **Sample Sites CY-Crater 1** (1.trip)

The yet unknown giant  $\emptyset$  320 km "Cape York Crater" (CYC) in NE-Australia is located on the ocean floor just east of the Cape York Peninsula.

The possible impact crater is noticeable on different gravity anomaly maps and on topographic maps.

According to my PT-Impact Hypothesis the crater belongs to a Secondary Impact Crater Chain, which was caused by ejecta material that was ejected from the  $\emptyset$  1270 x 950 km Permian Triassic Impact Crater (PTI), located in the Arctic Sea near Alaska. ( → see my **Study** about this Crater ).

The closest point on land in relation to the crater center is **Cape Melville** which probably represents a small section of the original outer crater-wall and which is only reachable on a difficult 4W-track or with a boat ( probably the best option ! ). The satellite image of Cape Melville shows hills of **large grey boulders of up to  $\emptyset$  20 m**. These grey boulders consist of **Cape-Melville-Granite with an Early-Permian Age**. But I haven't been on this site yet !

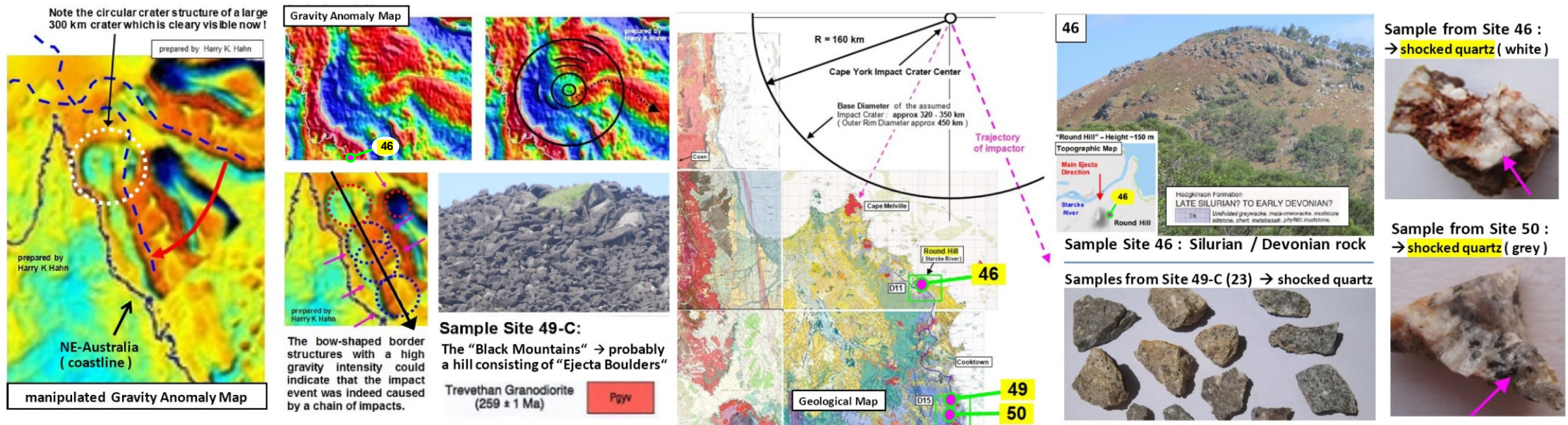
The closest site that I could reach on my 2.trip ( Cape York 2 ), in reference to the  $\emptyset$  320 km Crater, is **sample site 46** located approx. 75 km south of the crater-rim of the  $\emptyset$  320 km "Cape York Crater" ( → see map). This sample site is a hill consisting of Silurian-/ Devonian-age rock, accessible per road

**Raman spectra of quartz grains from sample site 46 clearly indicate a shock-event caused by an Impact**. This is strong indication for the existence of the  $\emptyset$  320 km "Cape York Crater". Further evidence comes from sample site 50. **The Raman spectra of quartz from sample site 50 also provides evidence for a large-scale impact event**. It shows similar shifts of the Raman peaks of the quartz to the lower frequencies, which indicates a **shock pressure of  $\approx$  20 - 22 GPa** that was caused by the large-scale "secondary impact event" ( crater-chain ) described in my hypothesis.

**Sample Site 49-C** is located at the "Black Mountains" 20 km south of Cooktown. These "Ejecta-Boulder-Hills" ( Black Mountains ) probably were formed during the large-scale Cape-York Impact. **The boulders of the "Black Mountains" consist of Trevethan Granodiorite with a given age of 259 +/- 1 Ma** which is very **close to the PT-boundary age of  $\approx$  253 Ma**. Cape Melville also seems to consist of these kind of Ejecta-Boulders from the PT-boundary

RAMAN spectra from quartz at site 49-C also indicate a shock event. However the shift of the Raman peaks is less and the evidence therefore weaker.

Weblinks : [Gravity Anomaly Map 1](#) ; [Gravity Anomaly Map 2](#) - Geological Maps : [Cape Melville](#) ; [Cooktown area](#)



## 6.) The Ø 30 km Mt Warning Impact Crater & 1.5 km Impact Crater ( East Australia ) :

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from the Sample Site **8-B2 /-B3**

→ **Raman spectra of samples from the 30 km Mt Warning Crater** ( or → [here](#) )

Photos of these Sample Sites & Rock Samples (and others) are available here : ► **Sample Sites "Mt Warning Crater"**

The Ø 30 km crater-shaped Mt Warning area and a smaller ≈ Ø 1.5 km crater structure, which is located directly near the crater-rim of the Mt Warning Crater, seem to belong to the large-scale impact event caused by the Ø 320 km Cape York Crater and by other large secondary craters of the PT-Impact Event.

( → see Study : [The 320 km Cape York Crater](#) ( link2 ) )

**Mount Warning** seems to be the result of a large **secondary impact** caused by the Cape York Impact Event in NE-Australia. And it is not the rest of an eroded shield-volcano as currently believed ! Therefore the true age of the Mt Warning crater may be ~253 Ma ( → PT-boundary age ).

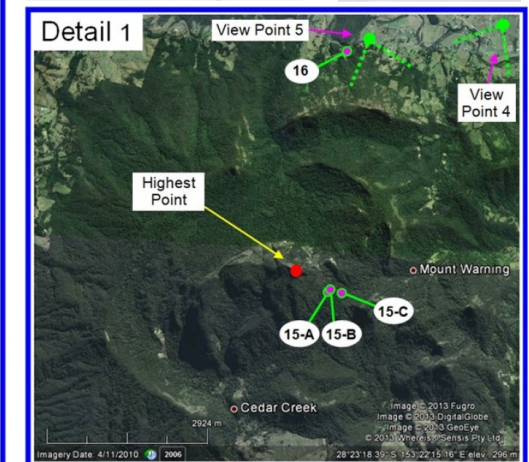
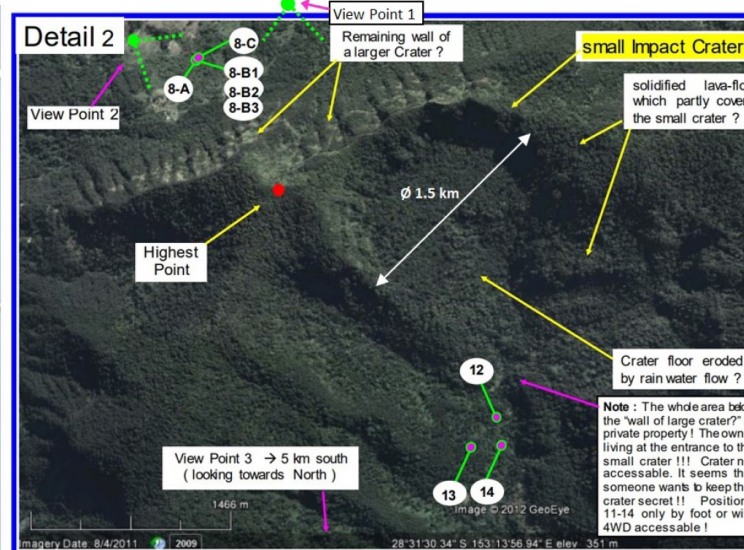
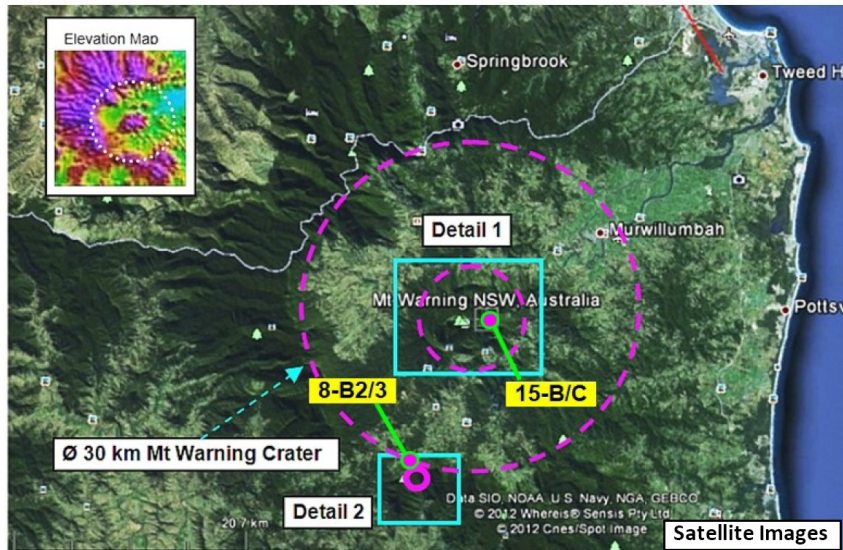
The chaotic looking central area of the Mt Warning crater-area (**Detail 1**) probably is the result of a shield volcano which grew on top of the Mt Warning impact crater after the Impact Event. When the volcanic activity ended, this shield volcano then heavily eroded and collapsed into the visible chaotic structure, which consists of magmatic material. Only the original Crater-wall of the Mt Warning crater is a remain of the original earlier impact event. (→ my hypothesis )

The samples **8-B2 /-B3** were collected on the foot of a possible remain of the original crater-wall of the Ø 30 km Mt Warning Impact Crater.

The **Raman spectra** of quartz from sample site **8-B2**, on the foot of the Mt Warning crater-wall, and on the outside of the smaller Ø 1.5 km circular crater visible in **Detail 2** provides **first indication for an impact event** ! The shifts of the main Raman peaks of the analysed quartz grain to lower frequencies, which is visible in Raman-spectra, indicates that the quartz from this site in all probability was exposed to a **shock pressure of around 20 - 22 GPa**.

The spectra of the rock samples from site **15-B** and **15-C**, the central mountain in the Mt Warning Crater, all indicate magmatic material.

**Geological Map:** → Moreton Geology : go to : [Geology Maps](#) → type in : **WARWICK**



## 7.) The Ø 8 x 7 km elliptical "Warwick Crater" in East-Australia

→ Shock-metamorphic effects of the Impact structure : **Shocked quartz** was found in rock samples from the Sample Sites **43, 51, 53 & 54**  
→ [Raman spectra of samples from the 8x7 km elliptical Warwick Crater](#) ( or → [here](#) )

Photos of these Sample Sites & Rock Samples ( and other sample sites ) are available here : ► [Sample Sites – Ø 8 x 7 km Warwick Crater](#)

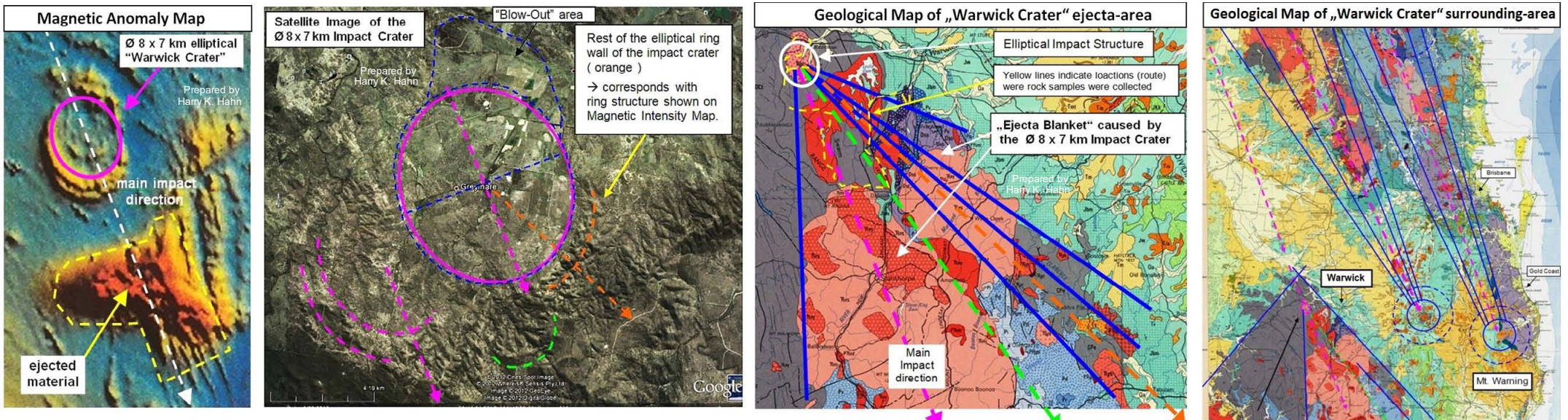
The Ø 8 x 7 km elliptical Warwick Crater is located ≈150 km south-west of Brisbane, near the Town Warwick ( ≈ 160 km west of the Mt. Warning area.).

There is a precise **Elliptical crater structure** noticeable on the **Magnetic Intensity Map**. This **elliptical ring structure** is not completely closed, which is an indication that the impactor arrived in a shallow angle. The orientation of the elliptical ring structure corresponds to the orientation of the ( assumed ) ejecta blanket. ( see marks ( lines ) on the geological map below ) The age of the oblique impact in all probability is ≈ **253 Ma**. ( PT-boundary age )  
( see explanation in Part 2 of my hypothesis about the PT-Impact Event )

The geological map of the surrounding area clearly shows a distribution of certain rock types along sectors, which are limited by „rays“, which all seem to come from the same starting point. And it seems that all rays have their starting point within the elliptical impact structure ! Only the rays which limit the sector of the grey colored rock type seem to have their starting point shifted a bit towards the direction where the impactor came from. It seems that the pink & red colored rock types were scattered during the impact towards the south-east, in a cone-shaped pattern. These rock-types probably represent the remains of the impactor that formed the crater. The **Raman spectrum of quartz from sample site 43 provides first evidence for an impact shock event**. The shifts of the main Raman peaks, of the analysed quartz, to the lower frequencies **463 and 204 cm<sup>-1</sup>**, provide indication for an impact event that caused a shock pressure of around 22 GPa.

**Further indication** comes from the Raman spectra of quartz grains from the **sample sites 53, 51 and 54** which show shifts of the main Raman peaks to the lower frequencies **263 and 205 (204) cm<sup>-1</sup>**, to the lower frequencies **263 and 205 cm<sup>-1</sup>**, to **260 and 126 cm<sup>-1</sup>** and to **262 (265) and 204 (207) cm<sup>-1</sup>**

The main impact direction of this elliptical Impact Crater points towards the Cape York Crater ( chain ). Therefore in all probability the Ø 8 x 7 km “Warwick Crater” was caused by a large ejecta fragment of the Cape York Impact Event. But it is also possible that it was caused by a large ejecta fragment of the PT-Impact Crater.  
( → Please also read the Study : [The 320 km Cape York Crater](#) ( [link2](#) ) )





## 8.) The Ø 40 x 33 km elliptical Pilbara Crater near Port Hedland ( NW-Australia )

→ Shock-metamorphic effects of the Impact : **Shocked quartz** was found in rock samples from the Sample Sites **25, 10 and 11**

→ [Raman spectra of samples from the 40 x 33 km Pilbara Crater](#) ( or → [here](#) )

Photos of these Sample Sites & Rock Samples ( and other sample sites ) are available here : ► [Sample Sites Pilbara Crater 1](#)

The Ø 40 x 33 km elliptical impact crater is located near the town Port Hedland in the North of Western Australia.

Because of the elliptical shape of the crater it is the result of an **oblique impact**. That means the impactor which formed the crater impacted in a very shallow angle of probably less than 10°. Because of this shallow impact angle, fragments of the impactor were ejected from the crater and caused complex secondary impact structures 40 km and 80 km further east of this elliptical crater. ( sample sites 10 and 11 are located here )

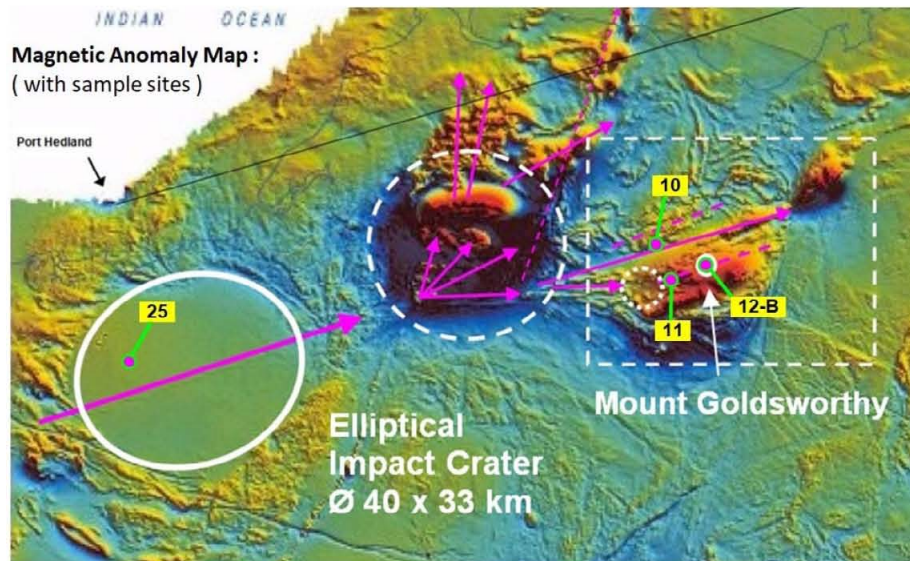
One of the secondary impact structures is **Mount Goldsworthy**, which is a famous **Iron Ore Mine** that contained the world's richest deposits of ferrous (iron)-ore with a share of up to 68 % iron. These impact structures are all noticeable on a magnetic anomaly map ( → see map below )

The Ø 40 x 33 km elliptical Impact Crater near Port Hedland probably was formed by ejecta material that was ejected by a larger crater near Onslow, a town on the NW-coast of Western Australia. This crater near Onslow in all probability was caused by the Permian-Triassic Impact Event 253 Ma ago ( in my opinion ) The rock of the area where the Impact-Structures are located in, is ≈ 2.9 Ga old. **But the impact structures seem to be much younger !** ( → see iron-outcrops )

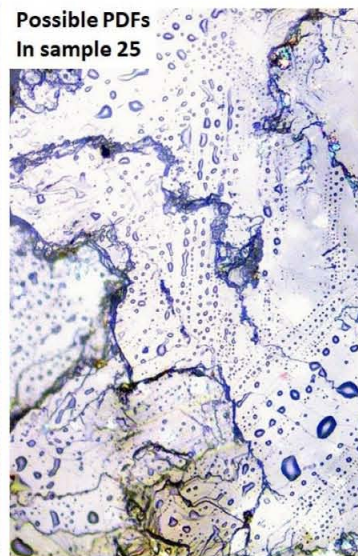
**Raman spectra of quartz grains from the sample site 25** near the center of the elliptical crater **and from the sample sites 10 and 11** located in the secondary impact structures of this crater **clearly indicate a shock-event caused by an Impact.**

The shifts of the Raman peaks of the analysed quartz samples to lower frequencies indicates an **impact shock pressure of ≈ 20 - 22 GPa**

Further evidence comes from a **microscopic image of sample 25** which indicates **planar deformation features (PDFs)**.



→ zoom-in to : [Geological Map: Port Hedland-Bedout Island](#)



Mount Goldsworthy in the 1960's  
→ Iron-Ore outcrops on the surface



Sample 25 (1)



Sample 25 (2)



Sample 10



Sample 11



## 9.) The Ejecta Ray from the $\approx \varnothing$ 420 km "Southern Ocean Crater (SOC)" in Western Australia

→ Shock-metamorphic effects of the Impact structure : **Shocked quartz** was found in rock samples from the Sample Sites **50, 52 & 55**

→ **Raman spectra of Ejecta-Ray samples of the 420 km Southern Ocean Crater** (or [here](#))

Other interesting rock samples are: **55** (ground consists of coherent mass of light-weight ceramic-like material which contains pipe-shaped gas-bubbles!) ; **53** (ground is full of black glass-like stones → Micro-Tectites ?) ; **49** (shocked quartz may be present here too!)

Photos of these Sample Sites & Rock Samples (& other sample sites) are available here : ► **Sample Sites - Ejecta Ray of the 420 km SOC**

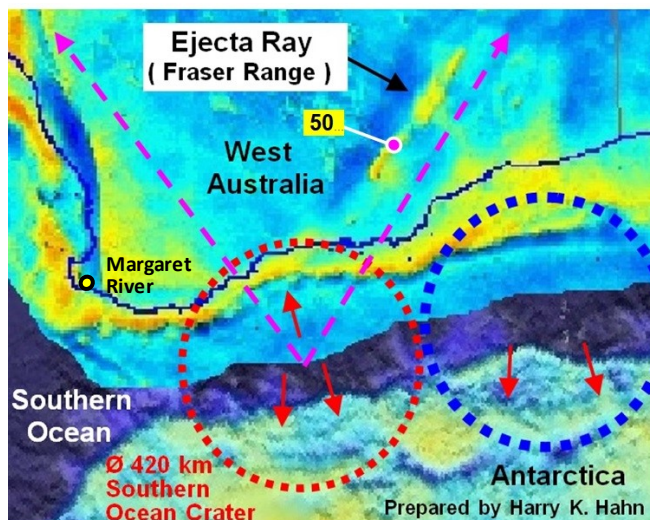
Note : Shock-metamorphic effects caused by ejecta from the  $\varnothing$  420 km Southern Ocean Crater may also be found in rocks of another area where I have collected samples : ► **Sample Sites - Margaret River Area** ; interesting sample areas : ► : **7-A & 7-B** and **8-A & 8-B**

The massive ejecta ray of the  $\approx \varnothing$  420 km "Southern Ocean Crater" is noticeable on gravity- & magnetic anomaly map of Australia. A map combination of a gravity anomaly map of Australia and a topographic map of Antarctica, arranged to each other so as they were  $\sim$ 200 Ma ago, shows the outline of the  $\varnothing$  420 km SOC.

A magnetic anomaly map provides clear evidence of the circular structure of the crater. And a geological map of the area south of Kalgoorlie indicates the precise linear structure of the **Fraser Range** which represents the massive ejecta ray that was ejected from the crater. The age of the rock which forms the linear Fraser Range is given with  $\approx$ 1.3 Ga. This is the age of the crust-material that was ejected by the SOC. But the impact event itself was at the PT-boundary!

Rock samples from the center line of this linear mountain range provide first evidence for an impact event. The **Raman spectra of quartz from sample sites 50, 52 & 55 provide first indication for an impact event!** The shifts of two main Raman peaks of the analysed quartz grains from **sample site 55** (Stone 1) to the lower frequencies **263 and 205  $\text{cm}^{-1}$**  and to **261/264 and 205  $\text{cm}^{-1}$** , and the shifts of two main Raman peaks in the quartz grains from **sample site 50** (Stone 2) to the lower frequencies **204 and 124  $\text{cm}^{-1}$**  and to **260/265 and 204 (200,209)  $\text{cm}^{-1}$**  (double peaks), and similar shifts in samples from **site 52**, which are visible in the Raman Spectra provide a first indication that the quartz from these sample sites was exposed to a **shock pressure in the range of 20-22 GPa**

The rock material from sample sites 50 and 55 may provide further evidence for the ejecta-ray-theory. On **site 55** the rock consists of **glass-like material that contains pipe-shaped bubbles filled with air** (or gas). Microscopic images of some analysed quartz grains from site 50, 52 & 55 may provide further proof for a shock event ( see : [Raman spectra of Ejecta-Ray samples of the 420 km Southern Ocean Crater](#) (or : [here](#))



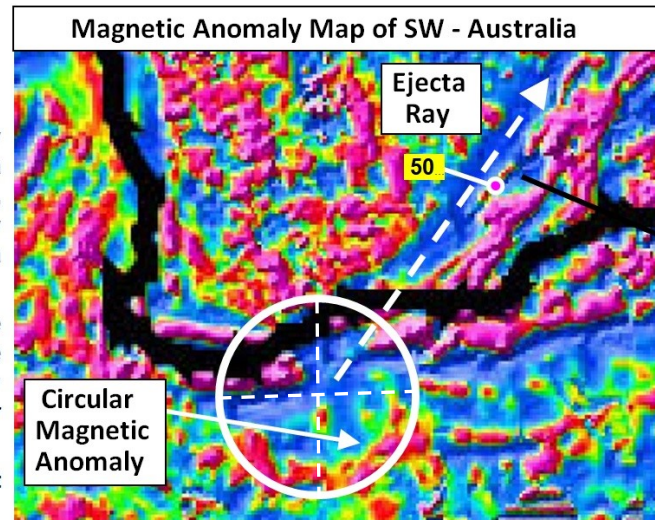
→ **Gravity Anomaly Map 1**

### Explanation to this map :

A map combination of a gravity anomaly map of Australia and a topographic map of Antarctica, arranged to each other, so as they were  $\sim$  200 Ma ago indicate a  $\approx \varnothing$  420 km Impact Crater.

Note the ring structures, the strong ejecta ray and the triangular shaped gravity anomaly which has its apex in the center of the red marked impact crater.

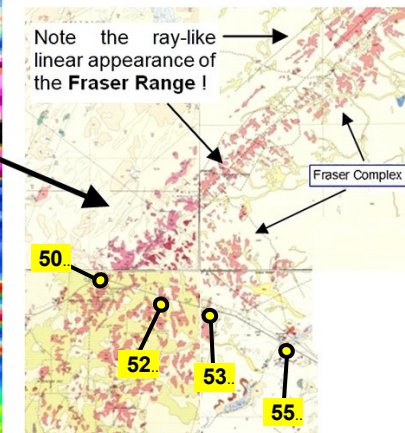
And there may be another impact crater ( blue marked ).



### Geological Maps

→ go to : "Geology" – 1:250K maps then select : Norseman/ Balladonia

→ 4 Geological Maps joined together



# 10.) Impact Area of the PTI-Ejecta Ray R4 & Impact Areas of Ejecta Rays from the Ø400x350 km Port Hedland Crater or from the Victoria Lake Impact ( E-Africa ) → located in Western Australia

→ Shock-metamorphic effects of these Impact structures : **Shocked quartz** was found in rock samples from different sample areas  
 Photos of these Sample Sites & Rock Samples ( & other sample sites ) are available here :

PTI - Ejecta Ray R4 : ▶ [Rock Samples from Margaret River Area](#) ( or here : [Margaret River Area](#) )

Ejecta Rays from the Port Hedland Crater or from the Victoria Lake Impact (VLC) in East-Africa :

▶ [Rock Samples from Kalgoorlie Area](#) ▶ [Rock Samples from Southern Cross Area](#) ▶ [Rock Samples of the Geraldton Area](#)

The Gravity Anomaly Map indicates that Ejecta-material from the Ø 400 x 350 km Port Hedland Crater or from the Victoria Lake Crater (VLC) in East-Africa probably impacted in Western Australia and formed the linear structures which are visible as positive anomalies (red) on the gravity anomaly map.

The map also indicates that the west coast of Western Australia was formed by the strong PTI - Ejecta Ray R4 according to my PTI – Hypothesis. → The analysed rock samples from the Margaret River area indicate an impact shock event caused by Ejecta Ray R4.

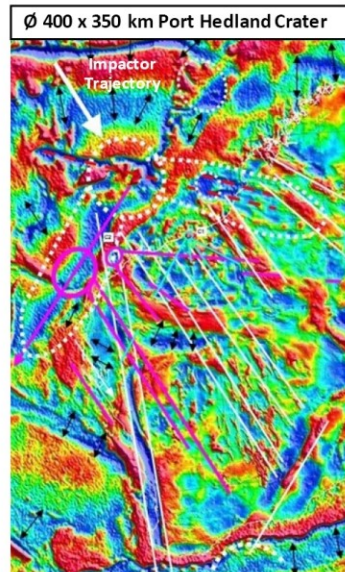
**Here the weblinks to the Raman-spectroscopy analyses results** which indicate shock metamorphic effects present in these areas :

Sample area to proof the PTI - Ejecta Ray R4 : ▶ [Raman analysis of samples from Margaret River](#) ( or here : [Link 2\\_MR](#) )

Sample areas to proof the Ejecta Rays from the Ø 400x350 km Port Hedland Crater or from the Victoria Lake Impact ( E-Africa ) :

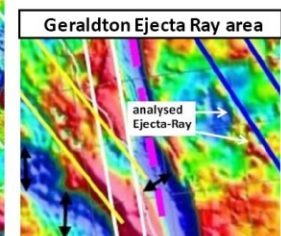
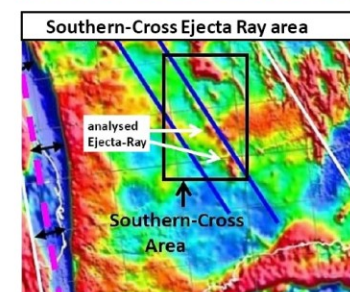
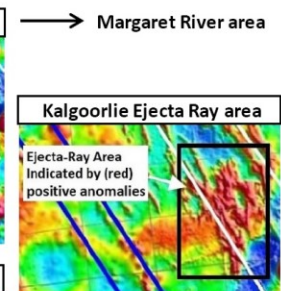
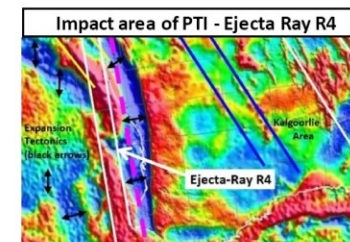
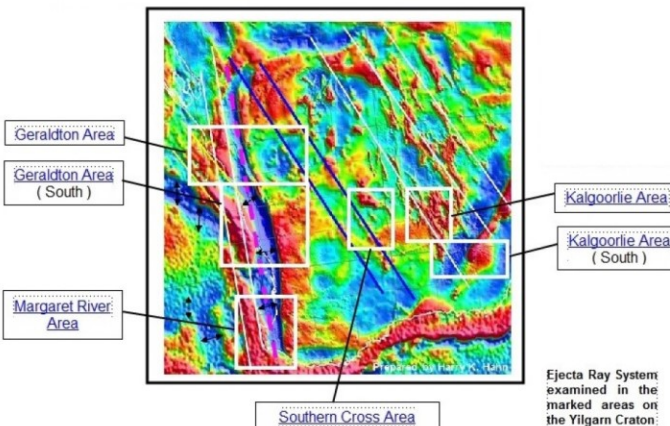
▶ [Raman analysis of Kalgoorlie samples](#) ( or : [Link 2\\_KAL](#) ) ▶ [Raman analysis of Southern-Cross samples](#) ( or : [Link 2\\_SC](#) )

▶ [Raman analysis of Geraldton samples](#) ( or : [Link 2\\_GER](#) )



## Gravity Anomaly Map of Western Australia :

The thin ejecta-ray-structures visible on the gravity anomaly map of Western Australia as linear ( red = positive ) anomalies, were caused either by the Ø400 x 350 km Port Hedland Crater (=Bengal Bay Crater) or by the Victoria Lake Impact Crater (VLC) in East-Africa according to my hypothesis



Ejecta Ray System examined in the marked areas on the Yilgarn Craton:

## → Other possible Secondary Impact Sites of the PT - Impact Event (PTI)

For the following possible Secondary Impact Sites of the PTI , I also will present Raman Spectra of some rock samples soon !

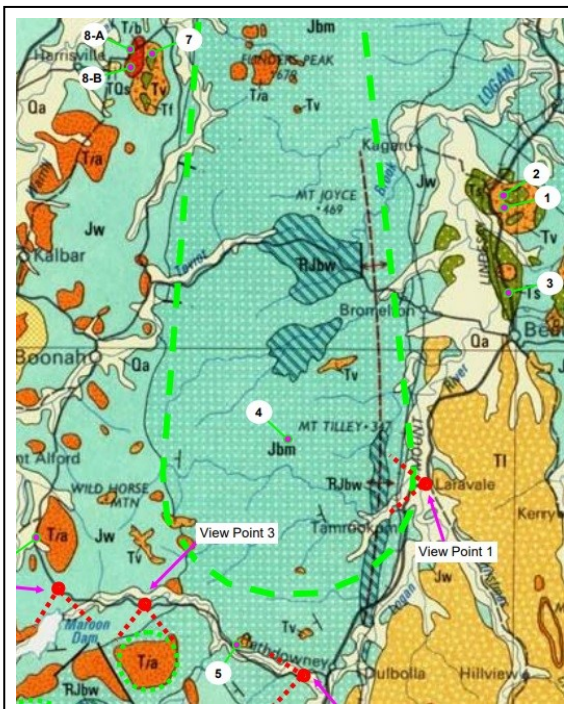
### 11.) The drop-shaped 60 x 15 km Secondary Impact Structure of the PTI, north-west of Mt. Warning (Australia)

→ Shock-metamorphic effects of the Impact structure : **weakly-shocked feldspar** was found in rock samples from the Sample Site **8-B**

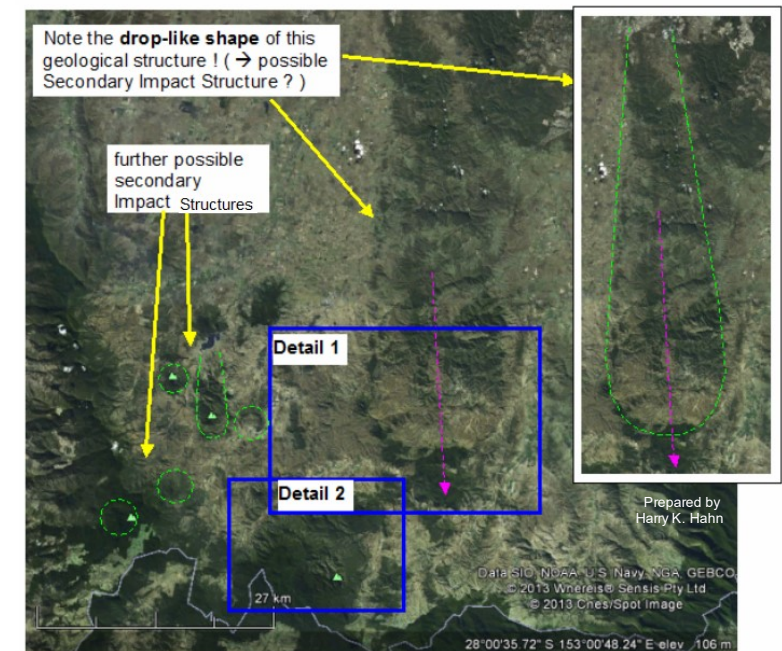
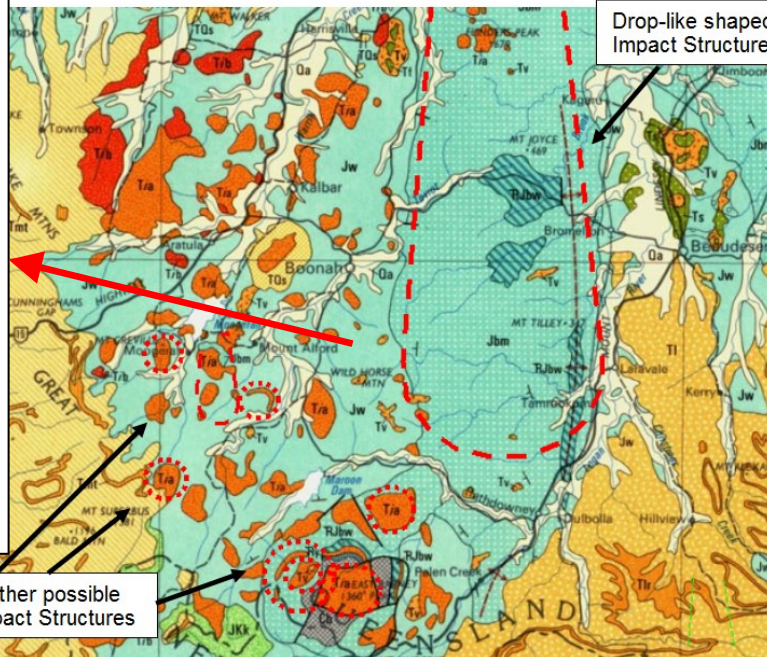
Photos of these Sample Sites & Rock Samples ( & other sample sites ) are available here : ► **Sample Sites – NW of Mt Warning** ( or here )



The 60 x 15 km drop-shaped secondary impact-structure ≈ 60 km north-west of Mt. Warning is visible on a satellite map ( see image below ). In all probability it was caused by the Cape York ( Crater Chain ) impact event. There are other smaller circular, ring-shaped and drop-shaped structures located on the left side of the larger structure, which also seem to be secondary impact structures. Sample site **8-B** is located on one of these smaller structures just ≈ 3 km left of the larger structure. Raman spectra of feldspar from sample site 8-B indicate weakly-shocked feldspar. This points to a shock-event caused by an Impact.



Geological Map : → Moreton Geology : go to : [Geology Maps](#) → type in : **WARWICK**



## 12-A.) The Ø 15 x 11 km "Anaga Crater" on Tenerife ( Canary Islands ) :

→ Photos of Sample Sites & Rock Samples are available here : ► [Sample Sites Anaga Crater](#) → Interesting sites: [5](#), [7](#), [9](#), [10](#), [54](#), [57](#) & [58](#)

→ Raman-spectra and microscope-images taken from rock samples are available here : [Raman spectra of samples from Tenerife](#) ( or : [here](#) )

Direct mineralogical evidence for an impact event ( shocked quartz ) wasn't found on Tenerife and on the other Canary Islands, but a [strong indication for an impact event](#) on Tenerife comes from the fracture pattern in the Anaga Range, which shows an area effected by compression stress and an area effected by tensile stress, separated by a curved rift zone (→ weblink (blue) opens a PDF with references to geological studies of Tenerife ► see [page 2](#) )

I believe that **the hot spots which caused the Canary Islands originally were impact sites of large ejecta fragments, which were ejected from the Permian Triassic Impact Crater** in the Arctic Sea. And I am sure that these impact sites ( hot spots ) **were produced by the same large-scale secondary impact event** (caused by the PT-Impact), **which also has formed the "Bay of Lyon Crater" and other impact structures in southern Spain** → see 1.) - 3.)

But it will be difficult to provide evidence for this hypothesis, because the evidence is buried under thick layers of lava and [magmatic rocks](#). Maybe a drill core analysis of rock material from locations close to the assumed original impact sites ( e.g. the center area of the "Anaga Impact Crater" ) may provide the evidence

I will publish **Raman spectra** of rock samples from the Canarian Islands **Tenerife, Gran Canaria & Fuerteventura** soon. Please have a look in the [vixra.org](#) or in the [archive.org](#) internet archive under my author name soon. Some of these Raman spectra or identified minerals may indicate the described impact event.

The **Anaga Range** on Tenerife belongs to the old basaltic shield of Tenerife, which is the oldest rock on Tenerife. The most rock on the Canary Islands is considered to be only a few million years old. But the base under the old basaltic shields is much older. **The oceanic ground where the Canary Islands are located on, definitely is >150 - 200 Ma old.** Therefore the deep base-rock under the Anaga-Range and Anaga-Crater may have PT-boundary age of ≈ 250 Ma

**An interesting site is an „Old rock Island“ inside the Pico del Teide caldera (site 58) which may also provide proof of the Anaga Crater impact event.**

This old rock could have a P/T-age of ~252 Ma. The old rock probably was lifted by the impact or by the growing volcano from the original ancient ocean floor(?)

I believe that the impact point of the Anaga Crater ( a "hot spot" ) drifted away from the original Anaga Crater later after the impact event (→ see [red arrow on the map](#) ! ) supported by an Expansion Tectonics process, and was responsible for the later formation of the **Pico del Teide Volcano** which is still active today.

On **sample site 7** close to the center of the assumed Anaga-Crater the geological map shows an area consisting of batholith material ( intrusive igneous rock ).

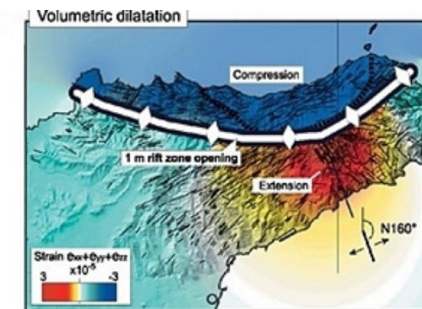
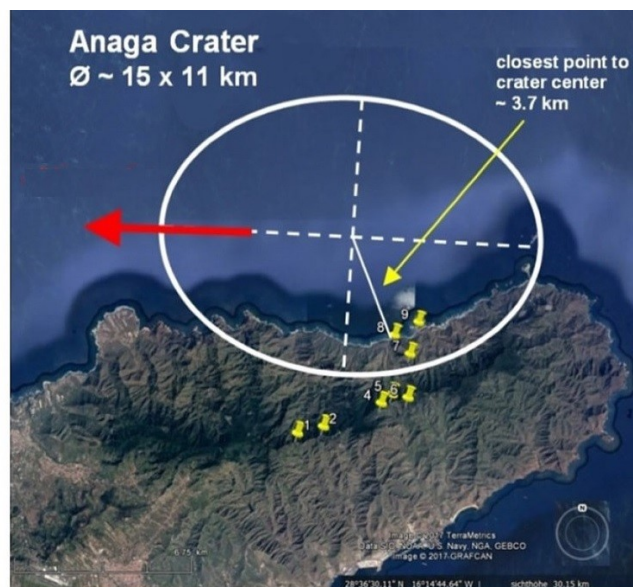
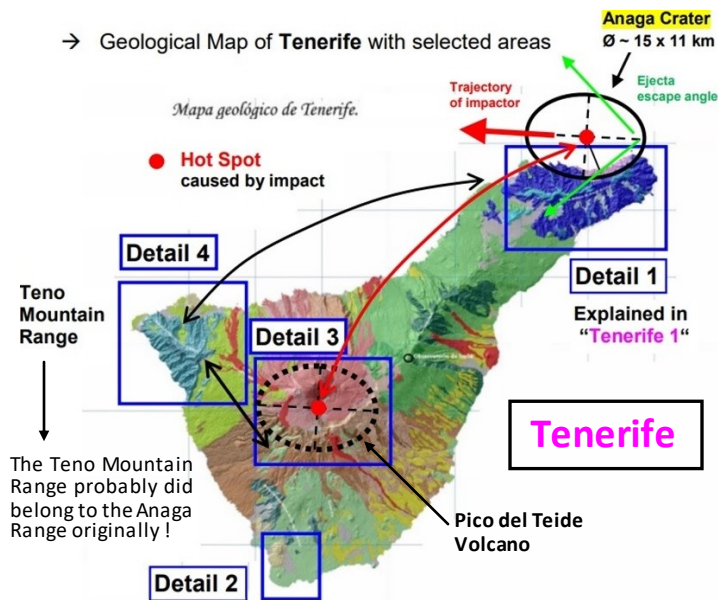


Fig. 7 Dislocation models calculated at a horizontal plane. A segmented rift zone was defined with an outline similar to the middle rift episode on Anaga. A curved tensile fault simulates the curved rift zone, uniform dislocation is 1 m. (A) Surface displacement vectors show that movement focused on the northern flank that is encircled by the rift zone. Dike intrusion along such a curved rift zone will thus promote flank creep. (B) Volumetric dilatation caused by 1-m horizontal widening of a curved rift zone. Dislocation models were calculated for a horizontal plane at 2 km depth, i.e. approximately at sea level. Positive strain (red color) matches the region where the third rift arm oriented NNW-SSE (160°) developed on Anaga. Negative volumetric dilatation is found elsewhere, strongest in the northern sector. Virtually complete absence of the NNW-SSE dike trend in the northern sector is due to the compressive field to the north of the curved rift

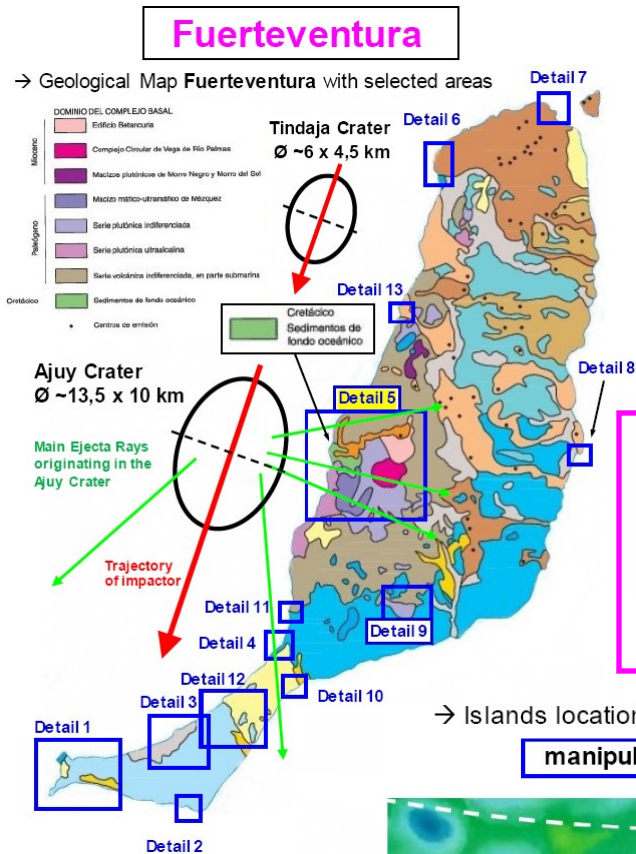
feldspar minerals



## 12-B.) The Ø 13,5 x 10 km "Ajuy Crater" on Fuerteventura

## 12-C.) The Ø 20 x 15 km "Tejeda Crater" on Gran Canaria

The Gravity Anomaly Map of the Canarian Islands indicates a large scale Impact Event. This impact event probably was the result of Ejecta from the PTI ( Permian Triassic Impact ) which impacted in this area and caused the Ø 430 x 290 km Gibraltar Crater (GIC). ( see explanation on page 28 of Part 2 of my PTI-hypothesis). The smaller oblique (elliptical) impact craters indicated on the Gravity Anomaly map offshore of the Islands Teneriffa, Fuerteventura and Lanzarote belong to this impact event and are located along the hypothetical crater-wall (-rim) of the GIC. On the canary island "Fuerteventura" old oceanic sediments with an age of ≈ 200 Ma can be found as fragments embedded in magmatic material near the village **Ajuy**, on the west-coast of Fuerteventura. It seems an impact has caused these fragments of old ocean sediments during the impact, and they were then mixed with (magmatic) ejecta material.



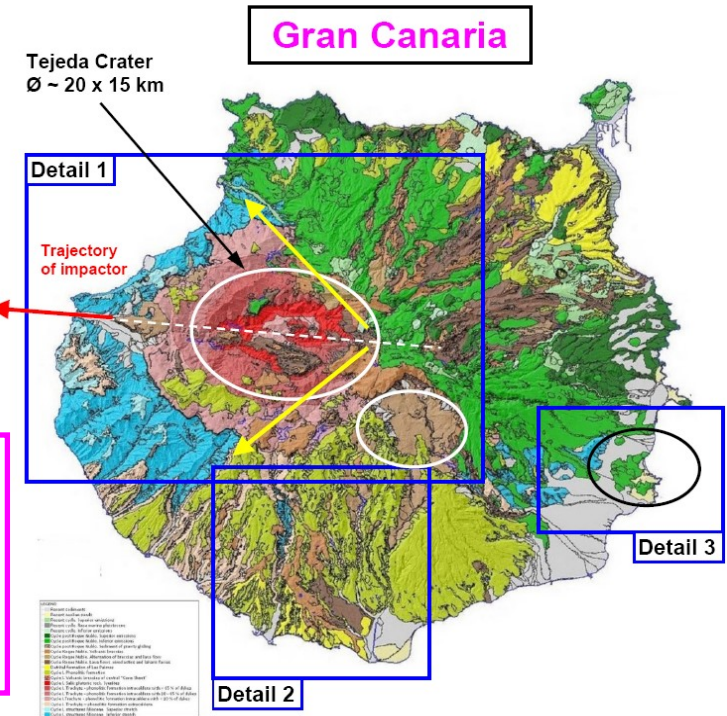
These fragments can be found in the **“Ejecta-triangle structures”** visible in **Detail 5** of the Geological Map of Fuerteventura. A precise age analysis of these old oceanic sediments should be done !

The gravity anomaly map indicates a Ø 13,5 x 10 km and a smaller Ø 6 x 4,5 km elliptical crater offshore of the west-coast of Fuerteventura and a Ø 12x9km Crater offshore of the NW-coast of Lanzarote

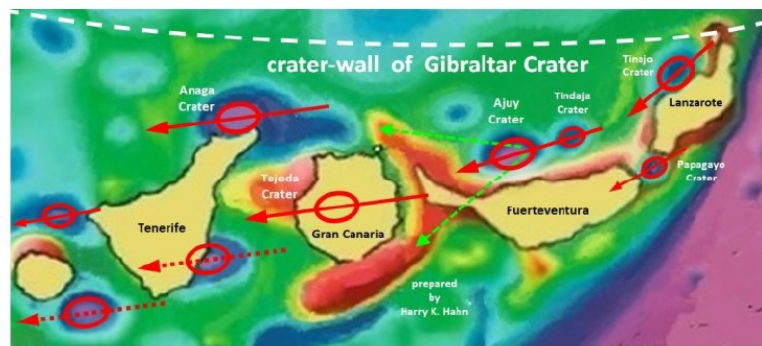
On **Gran Canaria** the big elliptical volcanic caldera near Gran Canaria's Center probably is the result of a shield volcano which grew on top of the assumed Ø20x15km **Tejeda Crater** → a secondary impact crater of the PTI !

→ **Raman-spectra** and microscope-images taken from rock samples are available here :

- 1.) Raman spectra of samples from **Fuerteventura** (or [here](#))
- 2.) Raman spectra of samples from **Lanzarote** (or [here](#))
- 3.) Raman spectra of samples from **Gran Canaria** (or [here](#))

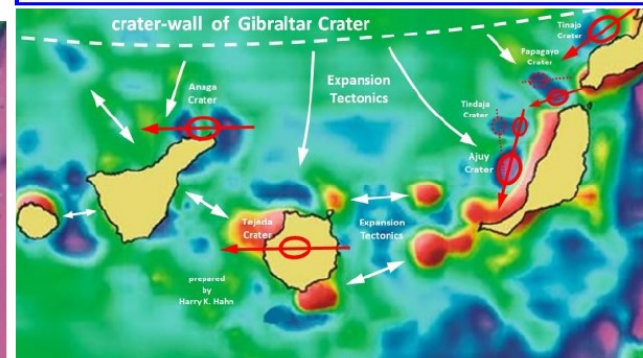


→ Islands locations shortly after the PTI - impact event :  
manipulated Gravity Anomaly Map :



→ original Gravity Anomaly Map :

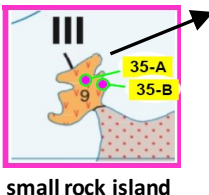
Gravity Anomaly Map – Canary Islands ( today ) :



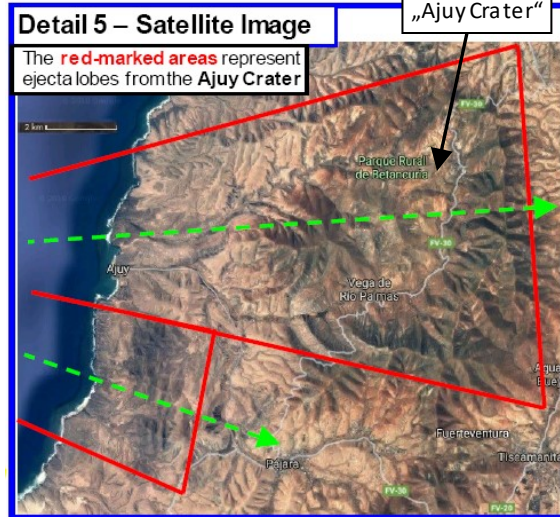
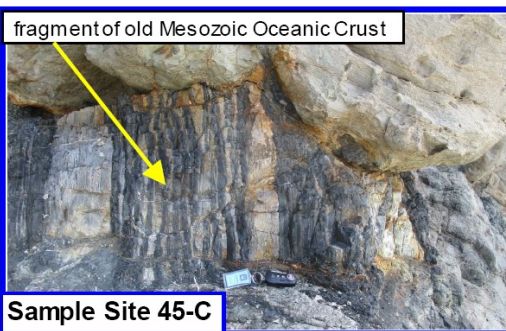
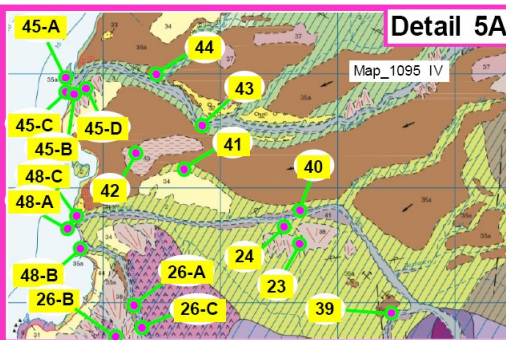
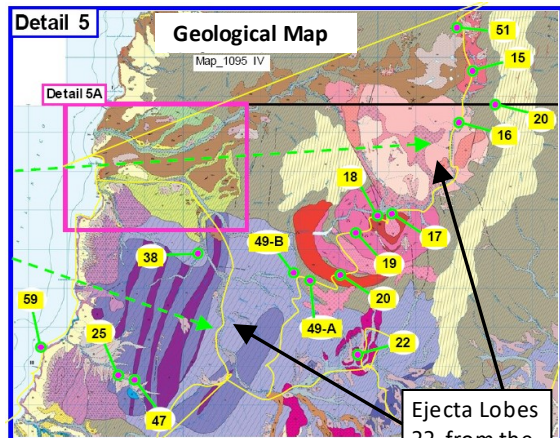
► **Photos Sample Sites & Rock Samples FUERT.: “Ajuy Crater”** (or: [here](#))

→ Interesting sites: **35-A, 45-A, 45-B, 45-C, 48-C, 56-A, 56-B & 21-A**

The above mentioned sites may indicate an impact event as cause of the hotspot which is responsible for the formation of Fuerteventura. Old oceanic sediments (older than >100 myr) which are embedded as fragments in magmatic rocks may be indication of an Impact Event around the PT-boundary.



Detail 3A → Sample Site 35 A



► **Sample Sites & Rock Samples GRAN C.: “Tejeda Crater”** (or: [here](#))

→ some interesting sites: **14, 20 & 25, 28, 29, 32, 33 and 34-B**

Interesting sites are around the Ø20x15km elliptical “Tejeda Caldera”, which I believe is the post-impact result of a PT-secondary impact that caused a hotspot and magma outflow here. Indication for an impact could be Magnetite minerals found on an “outflow tongue” on the frontend of the crater ( site 33 ).

Site 20/25 : area near Pico de las Nieves



Site 29 : iron-bearing minerals on this site



Site 33 : tip of outflow-tongue from Crater iron-bearing minerals found : e.g. **Magnetite** !



Site 34-B (& 32): breccia-rocks on the beach some iron-bearing minerals found ( on site 32 )



► **Sample Sites on Tenerife : “Anaga Crater”** (or [here](#))

→ Interesting sites : **5, 7, 9, 10, 54, 57 & 58**

sample site 7 : ( view over Anaga Range )



Site 58 : **old (mesozoic ?) rock island** inside the large Pico del Teide volcanic caldera !



## Appendix 1: A short overview: The Raman bands (peaks) of Quartz shocked with 22-26 GPa

In order to verify a sample site as an impact site or impact structure, [shock-metamorphic effects](#) must be discovered in the rocks of the sample site. This can be done by different methods.

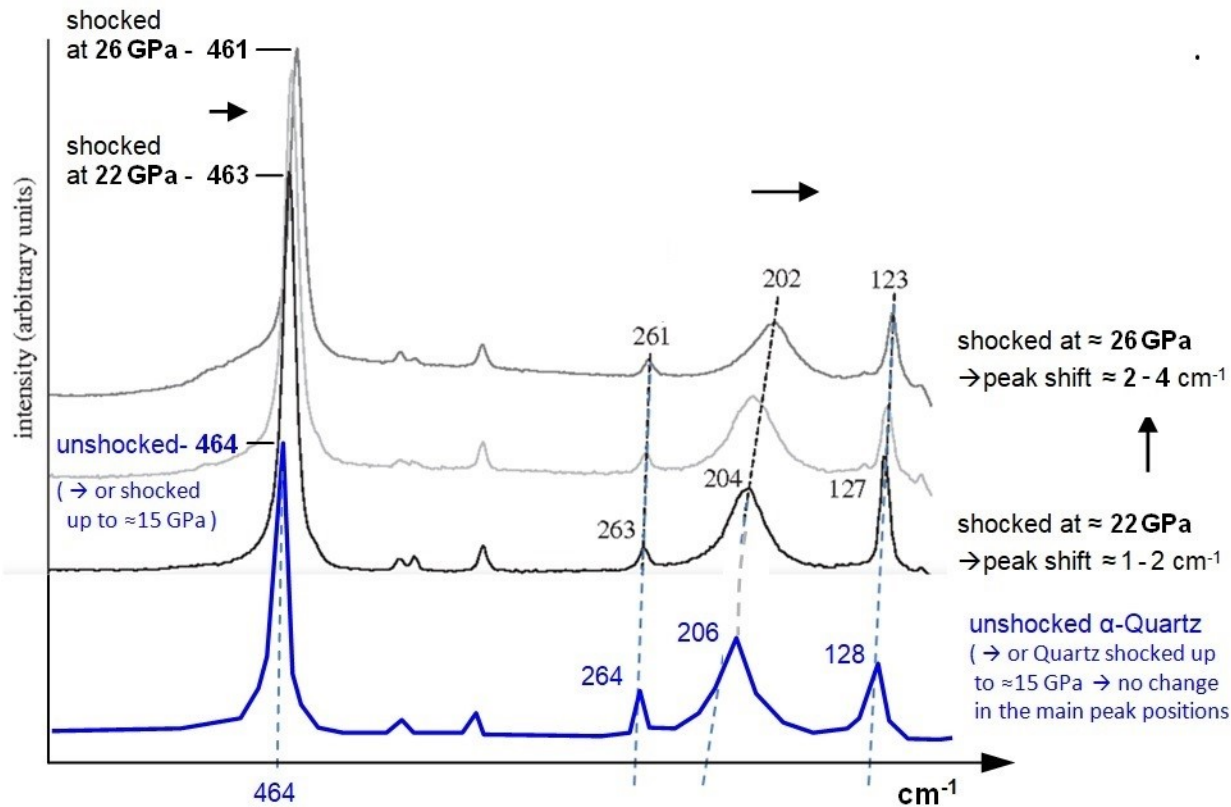
For example with the help of PDFs ( planar deformation features ) which are visible in the quartz with the help of a microscope. However this requires careful preparation of the samples and expertise.

Another, easier method, is the use of a RAMAN microscope.

[Micro-RAMAN Spectroscopy](#) on quartz grains in the samples can provide the first evidence for a shock event, that was caused by an impact.

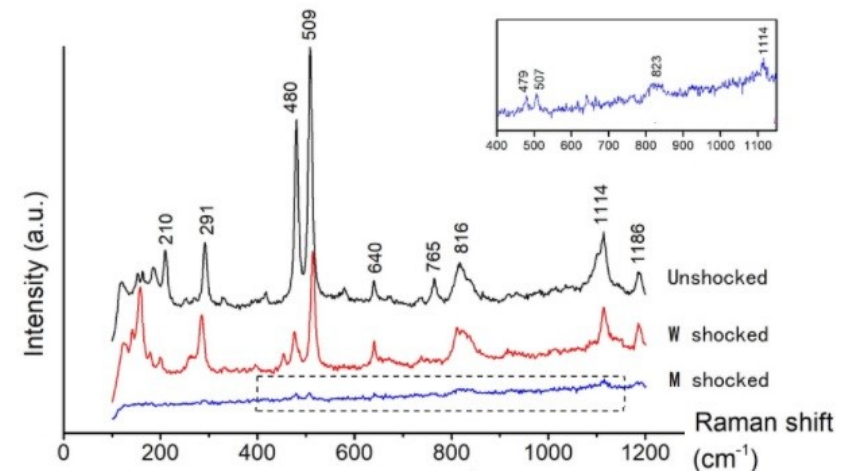
Mc Millan et al. (1992) and others have shown that the main RAMAN-peaks of Quartz shift towards lower frequencies if the Quartz was exposed the a shock-pressure > 15 GPa. → see diagram below

The shift of the main quartz RAMAN-peaks can be used to identify quartz that was shocked by an impact



**Quartz shocked with 22 GPa and 26 GPa** → shows shifts of the main RAMAN-peaks of 1 - 4 cm<sup>-1</sup> towards lower frequencies , compared with unshocked Quartz

## Appendix 2 : Raman spectra of (W) weakly-shocked & (M) moderately-shocked Alkali-Feldspar



Weakly shocked alkali feldspar mainly developed irregular fractures and undulatory extinction.

Note that the Raman-lines 210 and 765 are missing in the w-shocked feldspar, and an additional line at ≈ 150 appears.

The shock pressure for the w-shocked feldspar was estimated to be between 5 and 14 GPa



## References :

**Hypothesis about the Permian Triassic Impact Event (PTI) → weblinks to the Parts 1 to 6 of my hypothesis : → available on [vixra.org](http://vixra.org) and on [archive.org](http://archive.org)**

**Weblinks to my studies on → [vixra.org](http://vixra.org) :**

**Part 1 :** <https://vixra.org/abs/2012.0210>

**Part 2 :** <https://vixra.org/abs/2101.0052>

**Part 3 :** <https://vixra.org/abs/2101.0096>

**Part 4 :** <https://vixra.org/abs/2101.0067>

**Part 5 :** <https://vixra.org/abs/2101.0127>

**Part 6 :** <https://vixra.org/abs/2104.0099>

**Part 6b :** <https://vixra.org/abs/2110.0042>

**Weblinks to my studies on → [archive.org](http://archive.org)**

[Study-Part 1](#)

[Study-Part 2](#)

[Study-Part 3](#)

[Study-Part 4](#)

[Study-Part 5](#)

[Study-Part 6](#)

[Study-Part 6b](#)

## **Studies which indicate a Permian Triassic Impact Event :**

1. Kunio Kaiho, Y.Kajiwara, Yasunori Miura : [End-Permian catastrophe by bolide impact: Evidence of a gigantic release of sulfur from the mantle](#) September 2002, Tohoku University & Yamaguchi University, Japan
2. Jim Standard & C. Austen Angell : [Raining lead around 250 mya : A smoking gun for an Australian impact origin of the Permian Extinction](#) Department of Chemistry and Biochemistry, Arizona State University - A study which indicates a Permian-Triassic Impact Event in Australia :
3. C. Koeberl, F. Martinez-Ruiz : **Impact Markers in the Stratigraphic Record** 2003 ; Springer Verlag ; ISBN : 3-540-00630-3

**Lecture about the Permian-Triassic Extinction Event : [Permian-Triassic Mayhem: Earth's Largest Mass Extinction - YouTube](#)**

## **References to general studies about Impact Cratering :**

1. Dirk Elbeshausen, Kai Wünnemann, Gareth S Collins : [The transition from circular to elliptical impact craters](#) → or alternative : [weblink 2](#)
2. Dirk Elbeshausen, Kai Wünnemann : [The Effect of Target Topography and Impact Angle on Crater Formation](#) -- Insight from 3D Numerical Modelling
3. Michael H. Poelchau : [The subsurface structure of oblique impact craters](#)
4. Dr. Ludovic Ferriere : Introduction : **Impact Metamorphism** → weblink : <http://www.meteorimpactonearth.com/impactmeta.html>
5. W.U. Reimold, R.L. Gibson : **Meteorite Impact** ; Council for Geoscience, Germany 2009, Springer Verlag
6. R.L. Gibson, W.U. Reimold : **Large Meteorite Impacts and Planetary Evolution IV**  
The Geological Society of America, Special Paper 465 Boulder Colorado 2010 ; ISBN: 978-0-8137-2465-2
7. C. Koeberl, F. Martinez-Ruiz : **Impact Markers in the Stratigraphic Record** 2003 ; Springer Verlag ; ISBN : 3-540-00630-3
8. R.W.K. Potter : **Numerical modelling of basin-scale impact crater formation**  
→ <http://www.lpi.usra.edu/lpi/potter/publications/RossThesis.pdf>, see also: [Orientale impact](#)
9. **Crater Formation on the Moon** → [Animations to explain the Crater Formation on the Moon](#)

## References to studies about shock-metamorphic effects in minerals caused by an Impact, and to Raman-spectroscopy on such minerals :

**Shock-metamorphic effects in rocks and minerals** - <https://www.lpi.usra.edu/publications/books/CB-954/chapter4.pdf>

**Shock metamorphism of planetary silicate rocks and sediments: Proposal for an updated classification system**

Stöffler - 2018 - Meteoritics & Planetary Science – Wiley: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/maps.12912>

**Revising the shock classification of meteorites** - by Jörg Fritz, Ansgar Greshake : [Revising the shock classification of meteorites](#)

**A Raman spectroscopic study of shocked single crystalline quartz** - by P. McMillan, G. Wolf, Phillipe Lambert, 1992

<https://asu.pure.elsevier.com/en/publications/a-raman-spectroscopic-study-of-shocked-single-crystalline-quartz>

alternative : <https://www.semanticscholar.org/paper/A-Raman-spectroscopic-study-of-shocked-single-McMillan-Wolf/cfaaf6eb3e46fbd2912fb91c7acf40e88e721132>

**Raman spectroscopy of natural silica in Chicxulub impactite, Mexico** - by M. Ostroumov, E. Faulques, E. Lounejeva

[https://www.academia.edu/8003100/Raman\\_spectroscopy\\_of\\_natural\\_silica\\_in\\_Chicxulub\\_impactite\\_Mexico](https://www.academia.edu/8003100/Raman_spectroscopy_of_natural_silica_in_Chicxulub_impactite_Mexico)

alternative : <https://www.sciencedirect.com/science/article/pii/S1631071302017005>

**Shock-induced irreversible transition from  $\alpha$ -quartz to CaCl<sub>2</sub>-like silica** - Journal of Applied Physics: Vol 96, No 8

<https://aip.scitation.org/doi/10.1063/1.1783609>

**Shock experiments on quartz targets pre-cooled to 77 K** - J. Fritz, K. Wünnemann, W. U. Reimold, C. Meyer

[https://www.researchgate.net/publication/234026075\\_Shock\\_experiments\\_on\\_quartz\\_targets\\_pre-cooled\\_to\\_77\\_K](https://www.researchgate.net/publication/234026075_Shock_experiments_on_quartz_targets_pre-cooled_to_77_K)

**A Raman spectroscopic study of a fulgurite** – by E. A. Carter, M.D. Hargreaves, ...

[https://www.researchgate.net/publication/44655699\\_Raman\\_Spectroscopic\\_Study\\_of\\_a\\_Fulgurite](https://www.researchgate.net/publication/44655699_Raman_Spectroscopic_Study_of_a_Fulgurite)

alternative : <https://royalsocietypublishing.org/doi/abs/10.1098/rsta.2010.0022>

**Shock-Related Deformation of Feldspars from the Tenoumer Impact Crater, Mauritania** - by Steven J. Jaret

<https://trace.tennessee.edu/cgi/viewcontent.cgi?article=1002&context=pursuit>

**A Study of Shock-Metamorphic Features of Feldspars from the Xiuyan Impact Crater** - by Feng Yin, Dequi Dai

[https://www.researchgate.net/publication/339672303\\_A\\_Study\\_of\\_Shock-Metamorphic\\_Features\\_of\\_Feldspars\\_from\\_the\\_Xiuyan\\_Impact\\_Crater](https://www.researchgate.net/publication/339672303_A_Study_of_Shock-Metamorphic_Features_of_Feldspars_from_the_Xiuyan_Impact_Crater)

**Shock effects in plagioclase feldspar from the Mistastin Lake impact structure, Canada** – A. E. Pickersgill – 2015

<https://onlinelibrary.wiley.com/doi/pdf/10.1111/maps.12495>

**Shock Effects in feldspar: an overview** - by A. E. Pickersgill

<https://www.hou.usra.edu/meetings/lmi2019/pdf/5086.pdf>

**ExoMars Raman Laser Spectrometer RLS, a tool for the potential recognition of wet target craters on Mars**

[https://www.researchgate.net/publication/348675414\\_ExoMars\\_Raman\\_Laser\\_Spectrometer\\_RLS\\_a\\_tool\\_for\\_the\\_potential\\_recognition\\_of\\_wet\\_target\\_craters\\_on\\_Mars](https://www.researchgate.net/publication/348675414_ExoMars_Raman_Laser_Spectrometer_RLS_a_tool_for_the_potential_recognition_of_wet_target_craters_on_Mars)