P33D-2912
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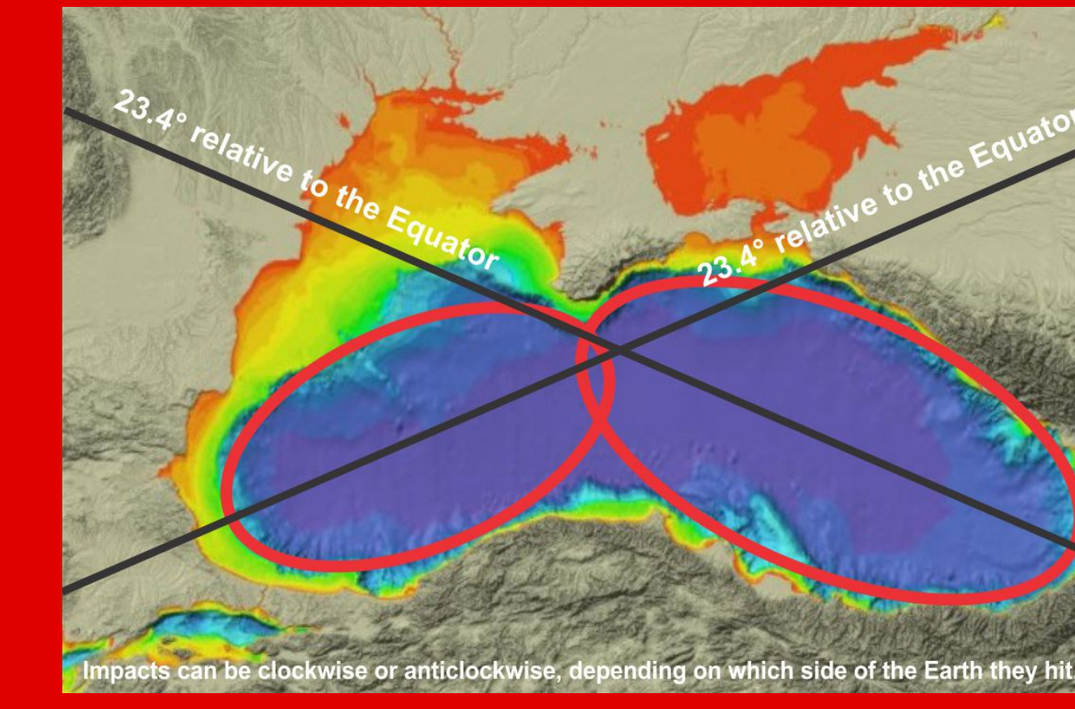
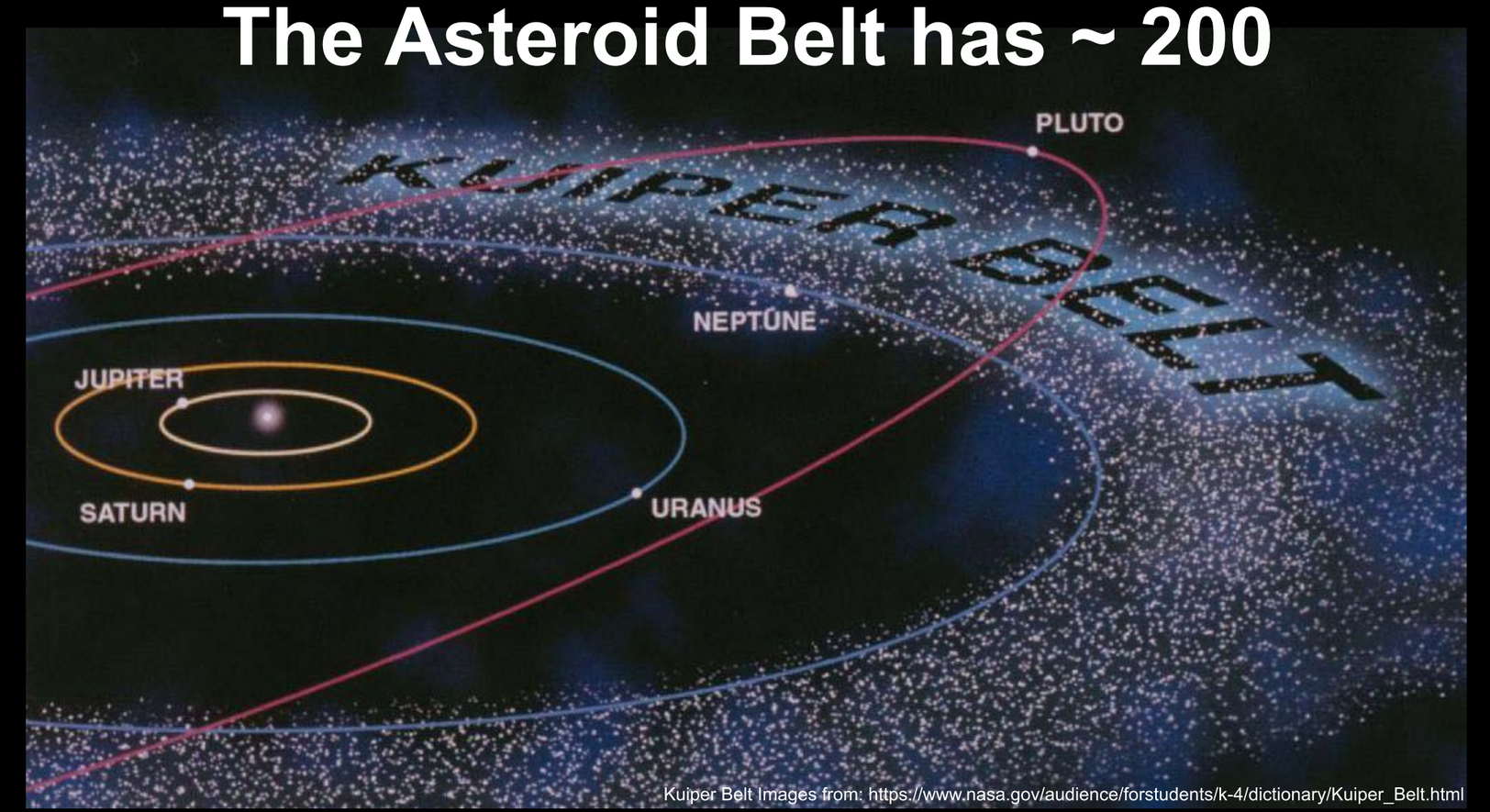
Tying Extinction Events to Comet Impacts Large Enough to Cause an Extinction in Themselves.



The Kuiper Belt has millions of potential comets

The Kuiper Belt is estimated to have 100,000+ objects over 100 km in diameter The Asteroid Belt has ~ 200

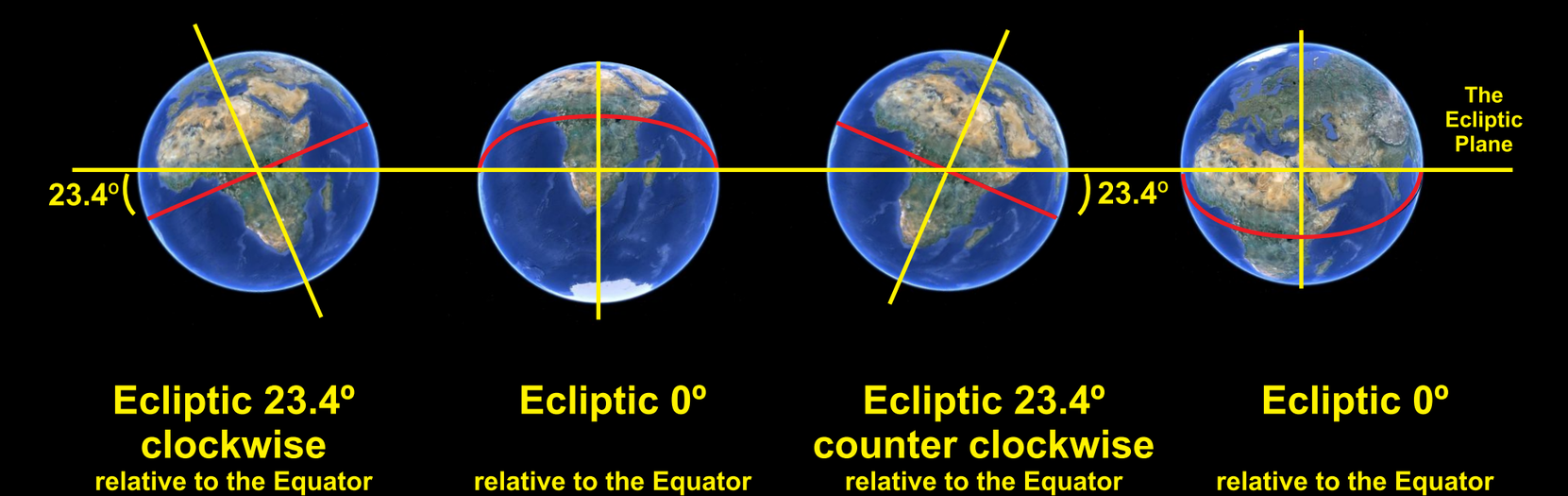


Most short period comets are from the Kuiper Belt or the related Scattered Disk

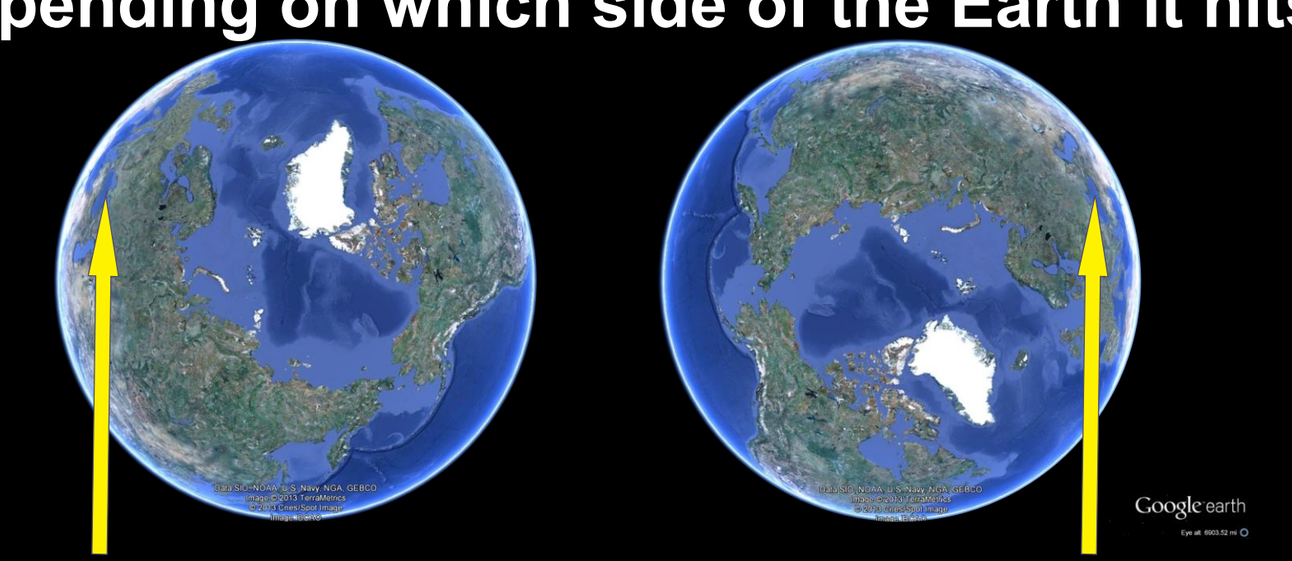
As the rings of Saturn are in a thin plane, the planets, asteroids and many comets lie in a thin plane called the Ecliptic.

Most objects in the Kuiper Belt are on the Ecliptic Plane.

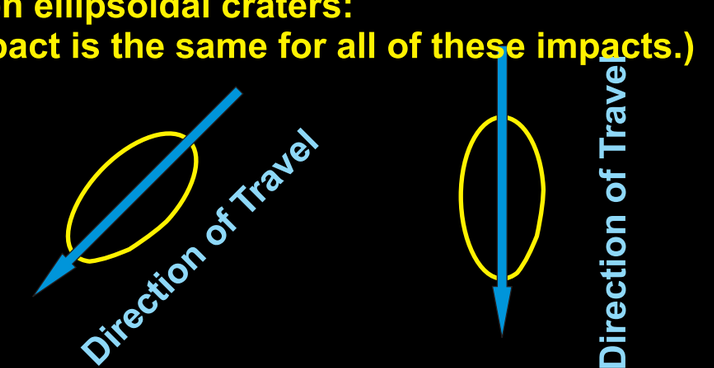
An impact from an object traveling in the Ecliptic can hit the Earth at any angle between 0º and 23.4º relative to the Equator, depending on when and where it hits.



A Comet traveling in the Ecliptic can hit at either 23.4º Clockwise or 23.4º Counter-Clockwise depending on which side of the Earth it hits.



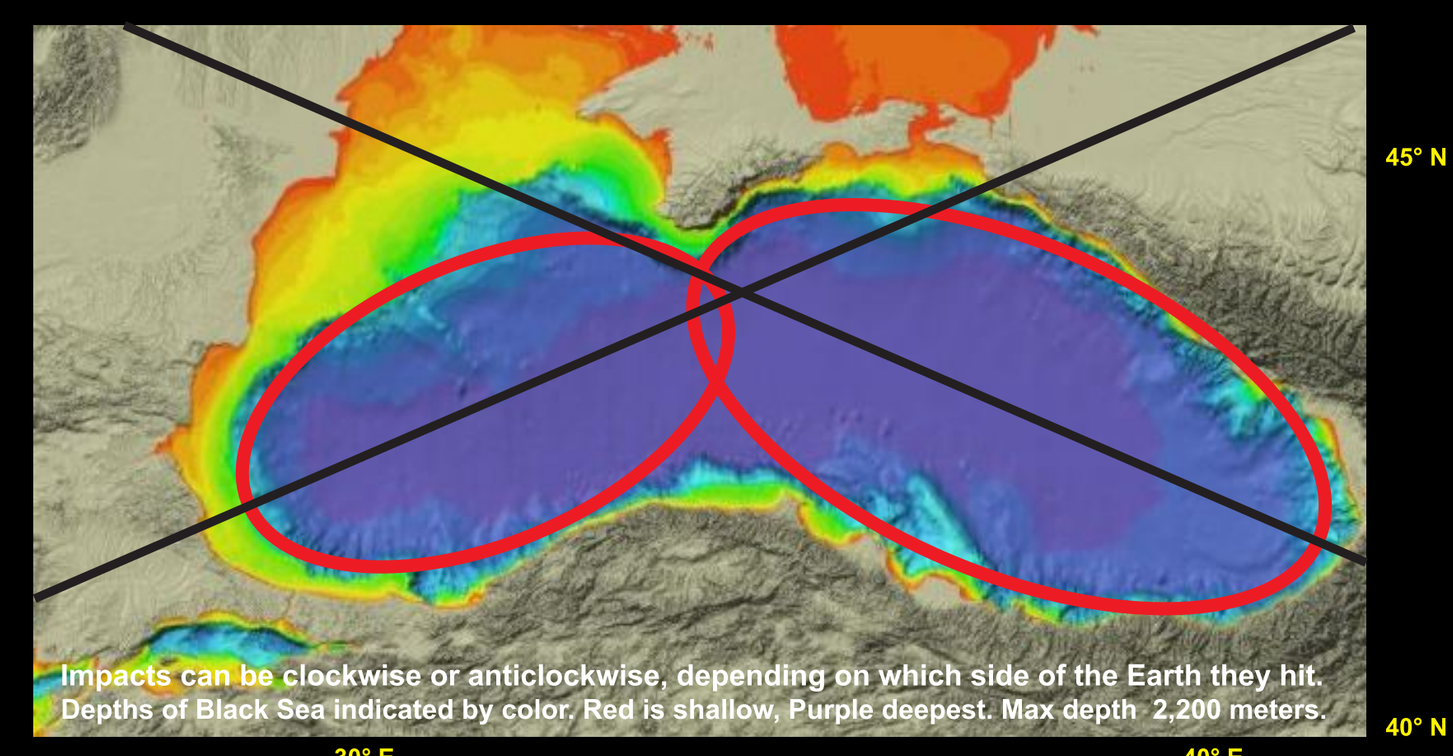
Direction of Travel effect on ellipsoidal craters:
(Note that the Angle of Impact is the same for all of these impacts.)



23.4º is not the only angle of travel possible, but it is a unique angle that can only relate to an impact, and not to tectonic processes.

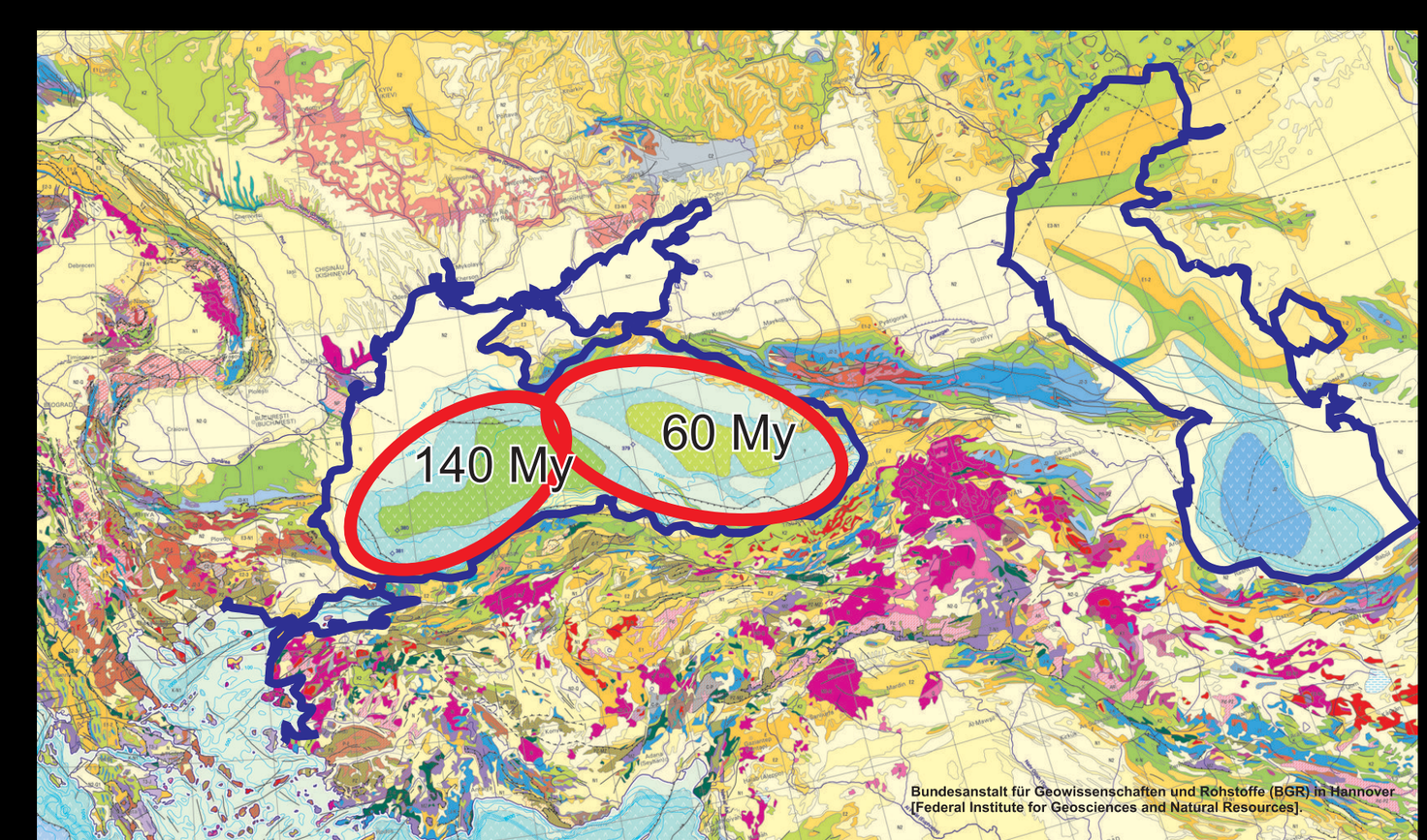
The Black Sea does NOT fit Tectonic explanations

The Black Sea is formed of 2 ellipses each orientated at 23.4º



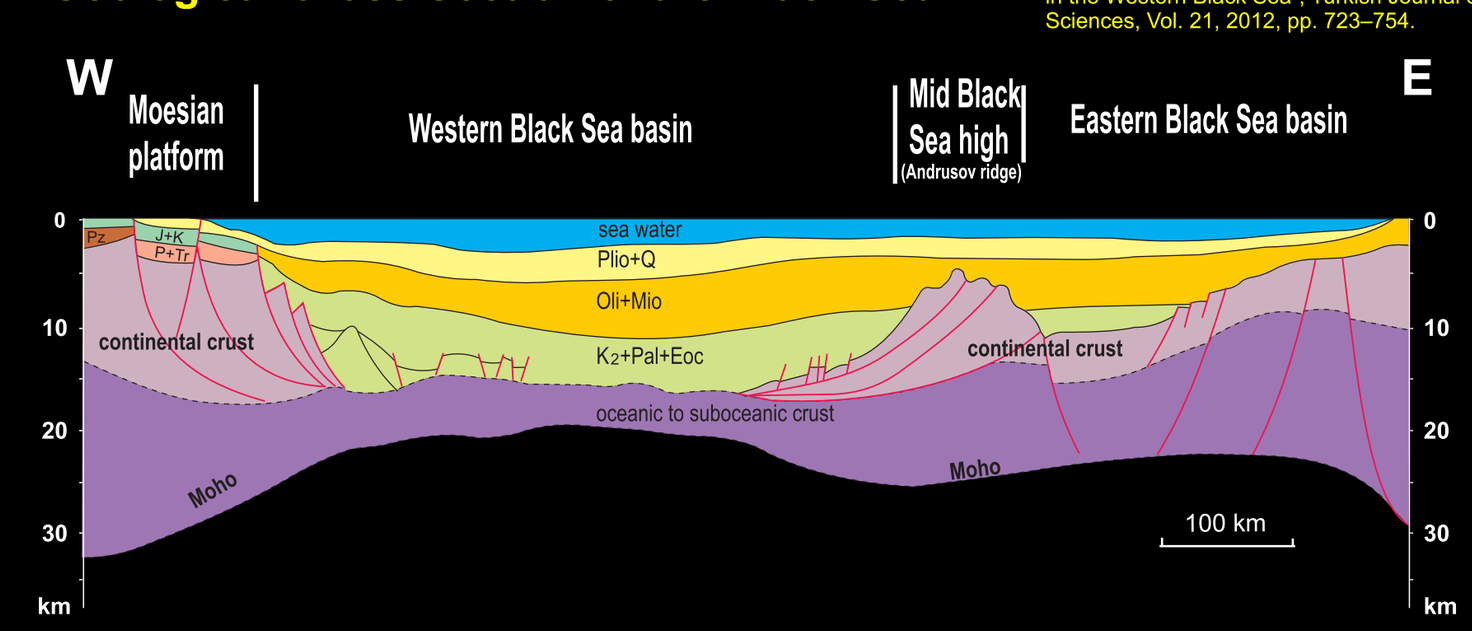
Black Sea Best Fit 23.4º ellipses: 490 km X 260 km; 630 X 345 km
Bathymetric image from GEBCO 2008 https://www.gebco.net/data_and_products/gridded_bathymetry_data/version_20100927/images/black_sea_update.jpg

The Black Sea and Caspian sea are listed as oceanic crust.
The west side of the Black Sea is Cretaceous, the east side, Paleocene.
It is recognized that the two halves are different.

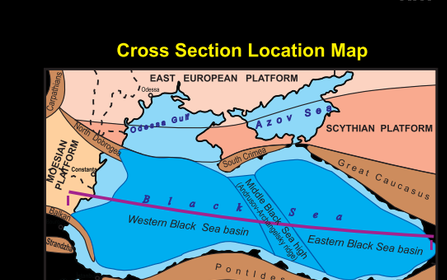


Geological Cross Section of the Black Sea

Georgiev, G., 2012, "Geology and Hydrocarbon Systems in the Western Black Sea", Turkish Journal of Earth Sciences, Vol. 21, 2012, pp. 723–754.

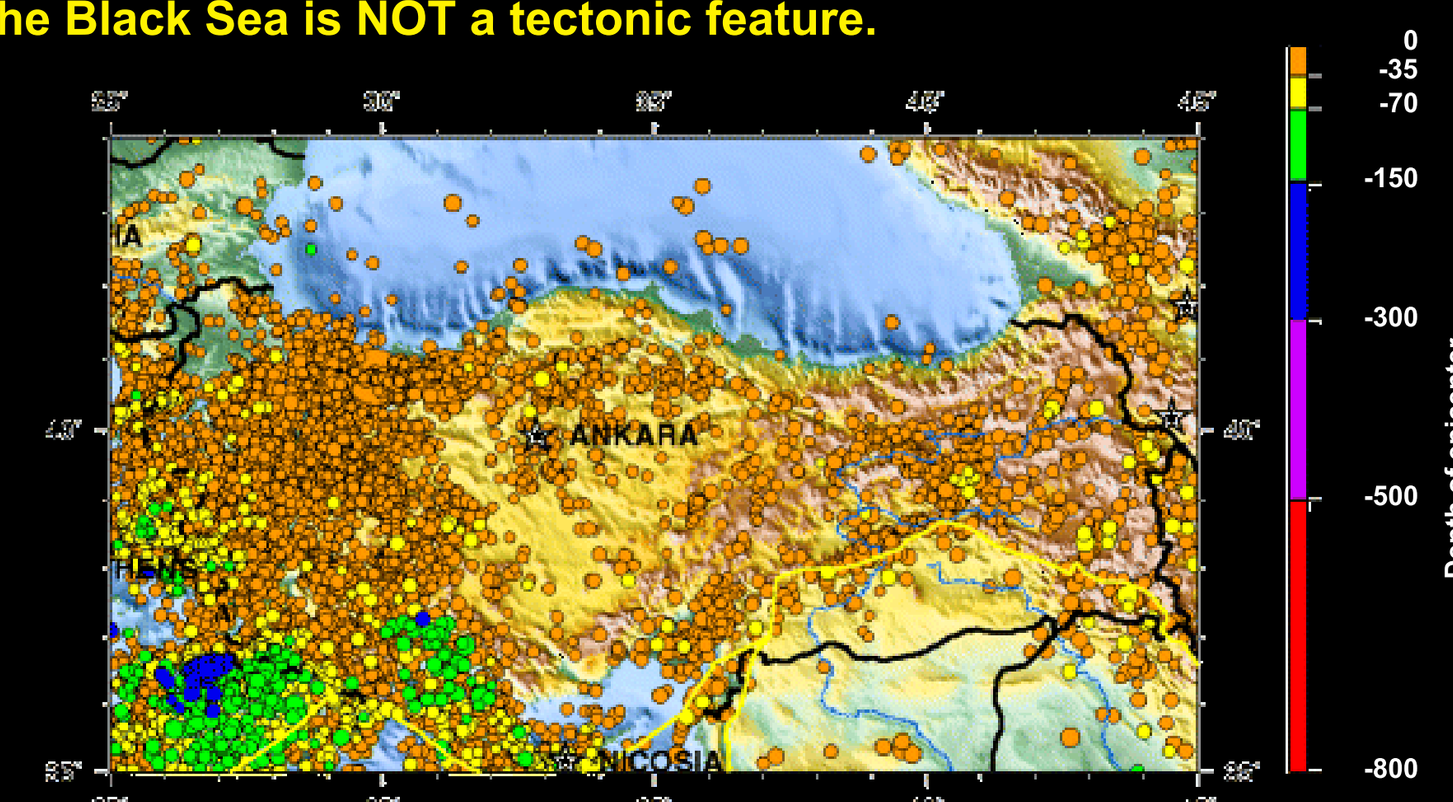


Note:
The thick broken continental crust all around.
The thin crust under the Black Sea.
The smooth, horizontal layers of sediment.
The depth of the sediments is 15 km deep.
The depth of the deepest ocean trench is only 11 km.



The USGS map of earthquakes in Turkey shows earthquakes are rare in the Black Sea, and abundant all around the Sea. The edge of the water is the defining point of the earthquake zones. Tectonic motions in any direction including depressions still have earthquakes.

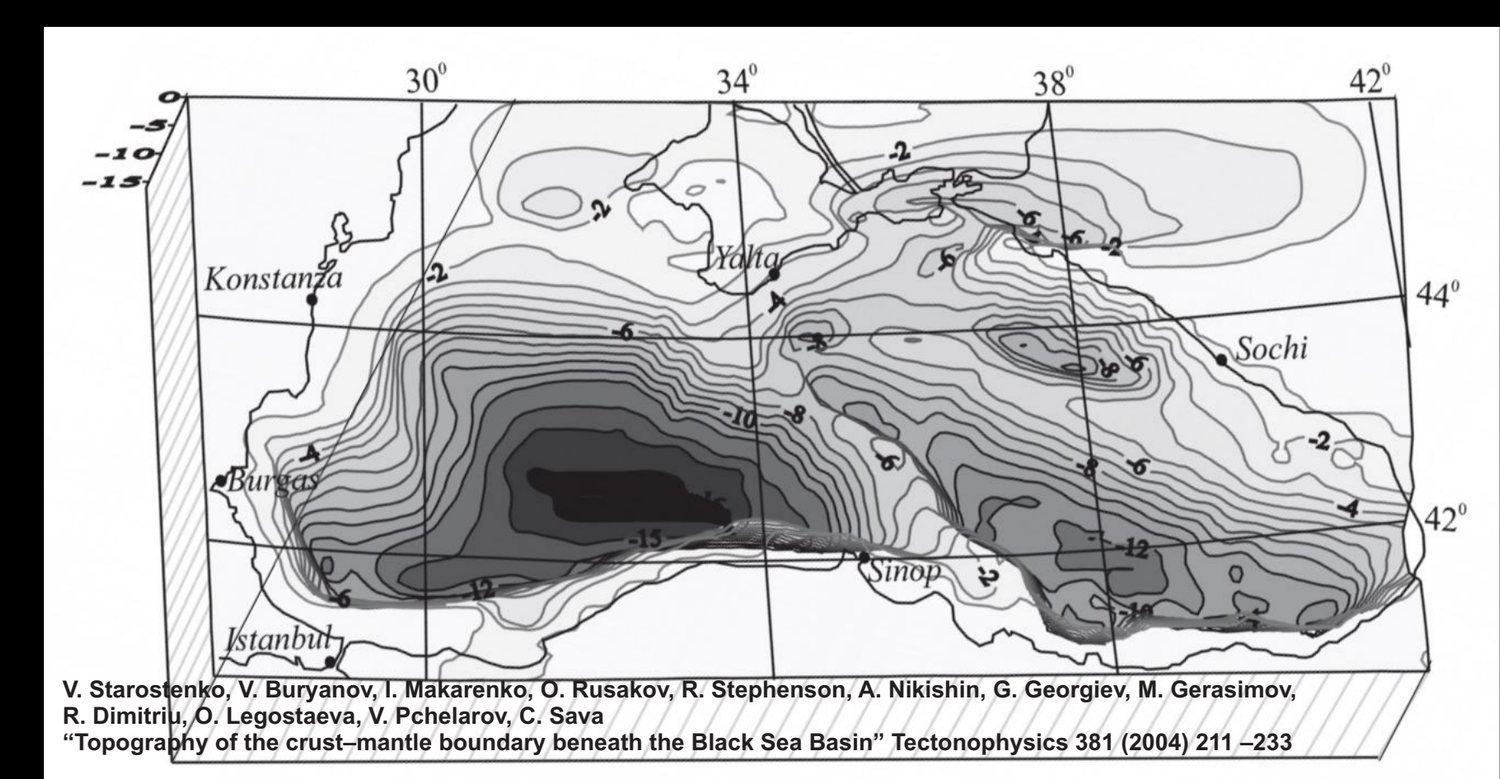
The Black Sea is NOT a tectonic feature.



USGS - Seismicity of Turkey, 1990 - 2006

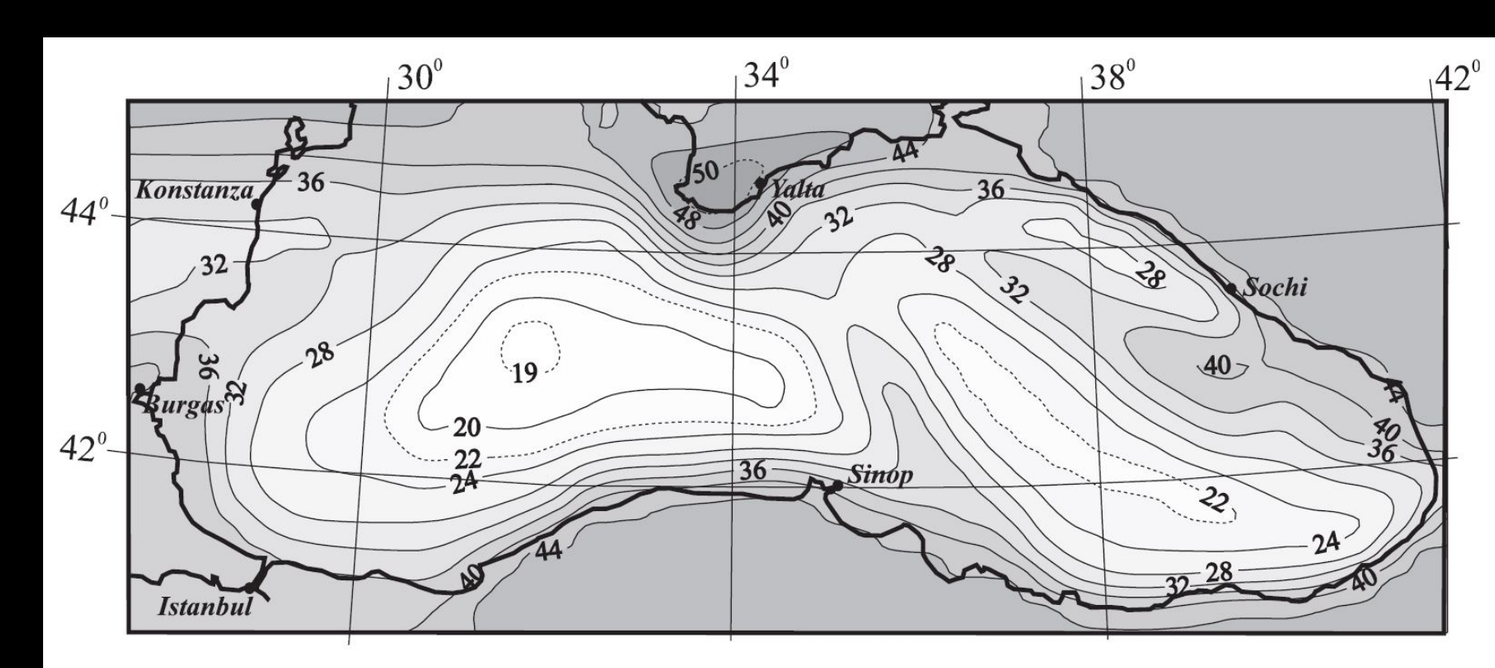
A Comet Impact would explain it better

The Black Sea with sediments removed: A 16 km deep hole.
It is TOO DEEP to be an ocean feature.



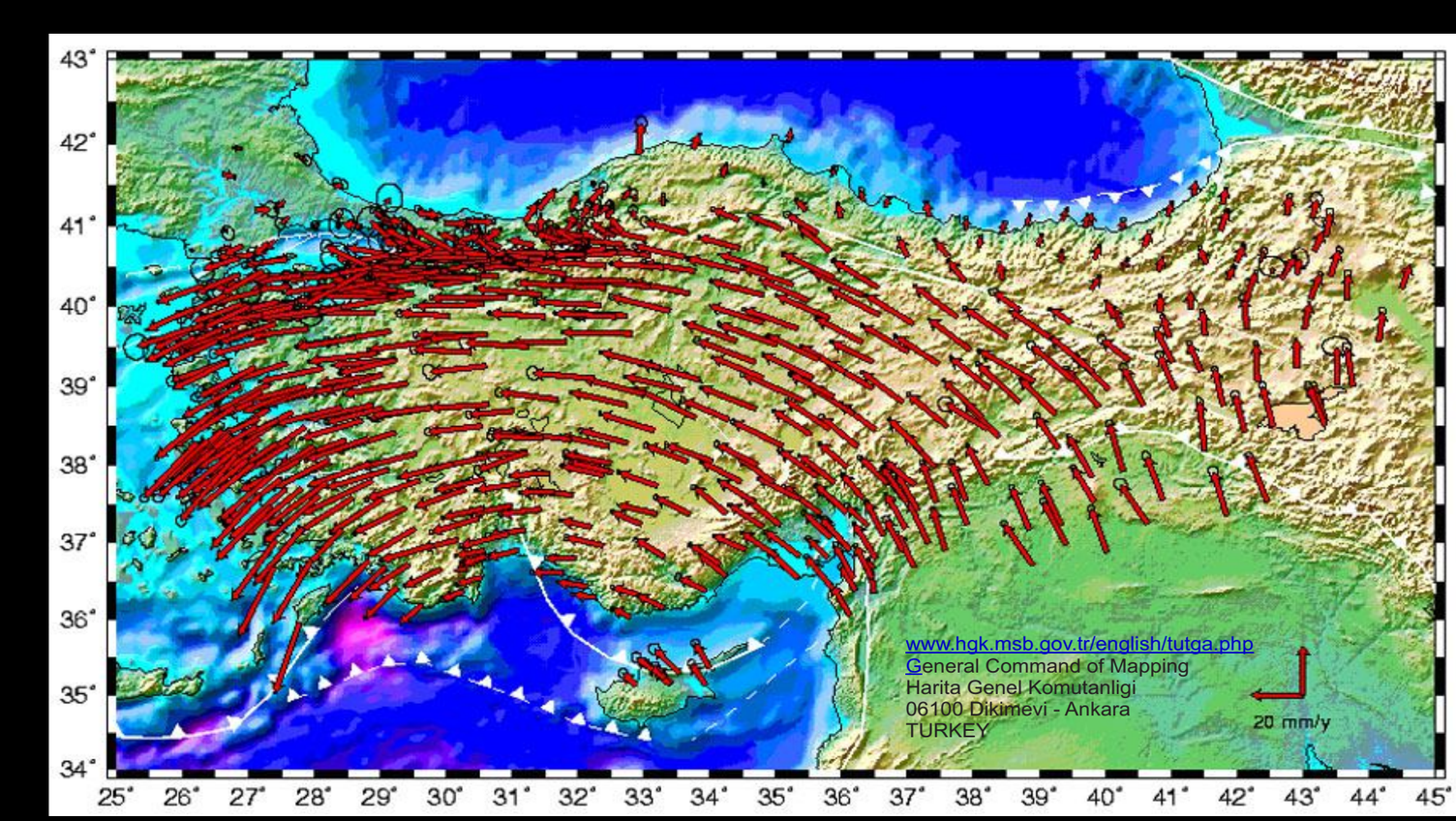
Depths to the bottom of the consolidated layers in the Black Sea (km)
Starostenkoa, V. et al., 2004, "Topography of the crust–mantle boundary beneath the Black Sea Basin", Tectonophysics 381 (2004) 211 –233

The Moho under the Black Sea: Highest under the deepest area.
In the center the crust is only 3 km thick



Moho depths in the Black Sea Basin (km)
as inferred from the interpretation of the gravitational response of the crystalline crust.
Starostenkoa, V. et al., 2004, "Topography of the crust–mantle boundary beneath the Black Sea Basin", Tectonophysics 381 (2004) 211 –233

Detailed GPS measurements of plate motion in Turkey show that the crust is being diverted around the Black Sea. The general motion of Africa and Europe is to the north-east. The diversion around the Black Sea is AGAINST the flow of the mantle. It requires a lot of force to divert the crustal motion: a hole can not do that, but an impact can.



GPS Maps showing surface motion in Turkey, 2007.
GPS Map from https://www.hgk.msb.gov.tr/english/u-10-turkish-national-fundamental-gps-network.html
based on work published by
McClusky et al, 2000, "Global Positioning System constraints on plate kinematics and dynamics in the eastern Mediterranean and Caucasus", Journal of Geophysical Research, Vol. 105, # B3, Pg 5695-5719.
Reilinger et al., 2006, "GPS constraints on continental deformation in the Africa-Arabia-Eurasia continental collision zone and implications for the dynamics of plate interactions", Journal of Geophysical Research, Vol. 111, B05411

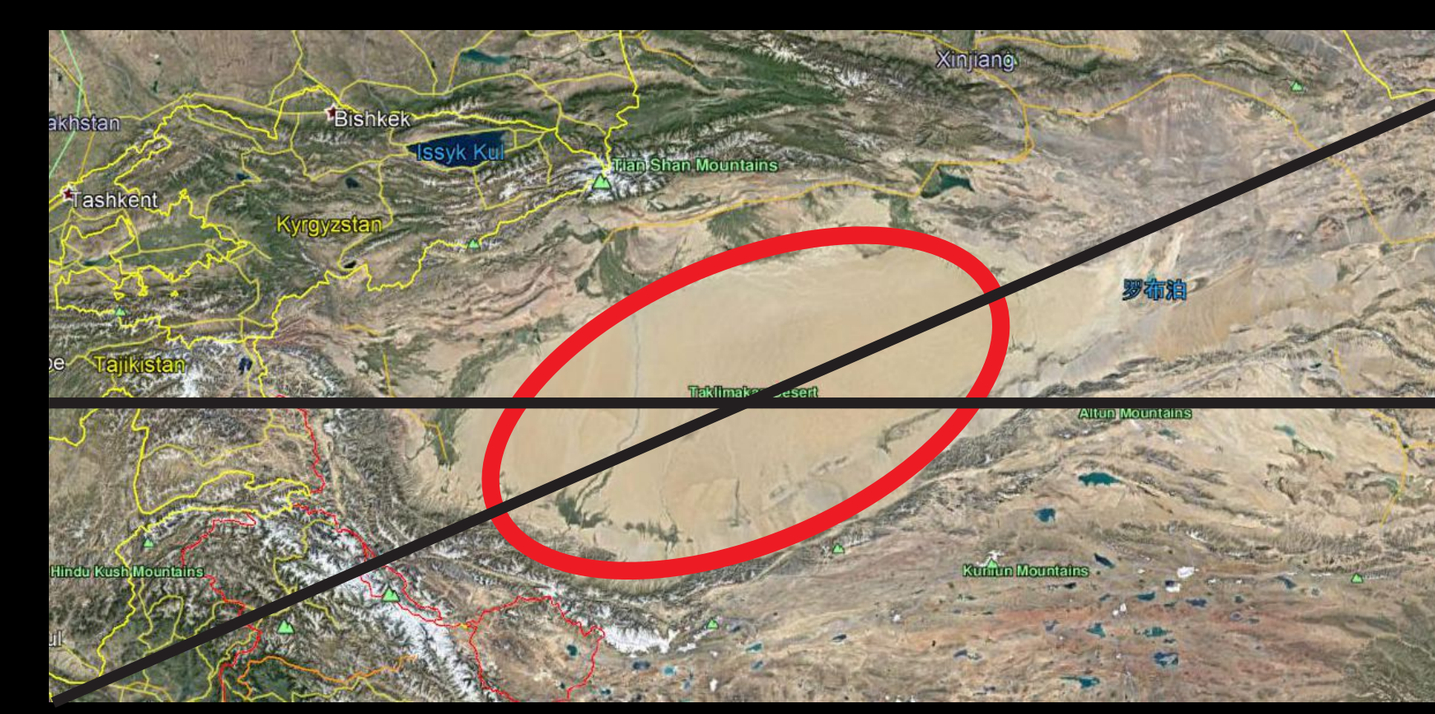
Summary of defining features leading to impact theory

1: 23.4º major axis of elliptical shaped depression.
2: Very thin ocean crust in the Black Sea depression.
3: The Black Sea is an Excessively Deep depression - much deeper than the deepest part of the ocean.
4: Deep sediments in nearly horizontal layers fill the depression.
5: Few earthquakes occur in the Black Sea depression, but there are many earthquakes around it right up to its edge.
6: Geology of depression dramatically different than surroundings
7: The Black Sea is apparently pushing the Turkish crust away.
8: Plate Tectonics can not explain the feature's shape or presence.

A low angle impact would explain all of the above.

The Tarim Basin matches the Black Sea features

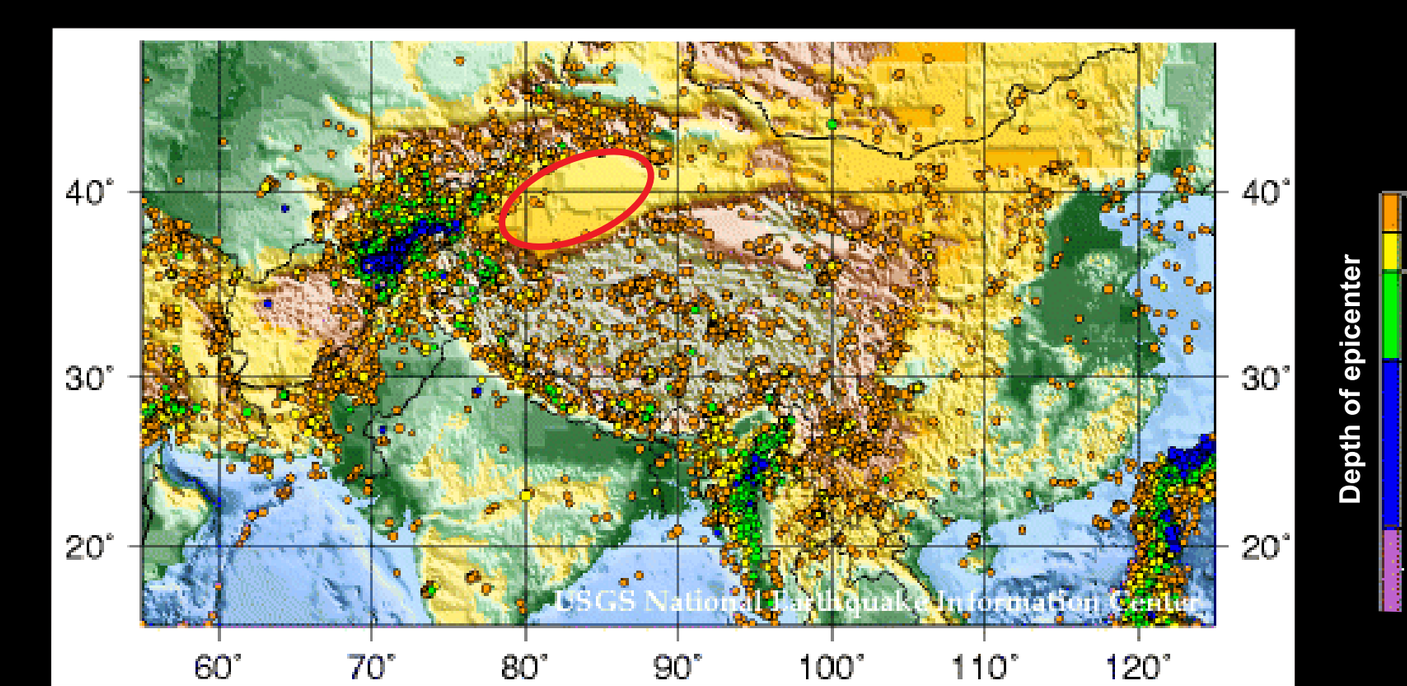
The Tarim Basin is formed of an ellipse orientated at 23.4º



Tarim Best Fit 23.4º ellipse: 880 km X 450 km
Image from Google Earth

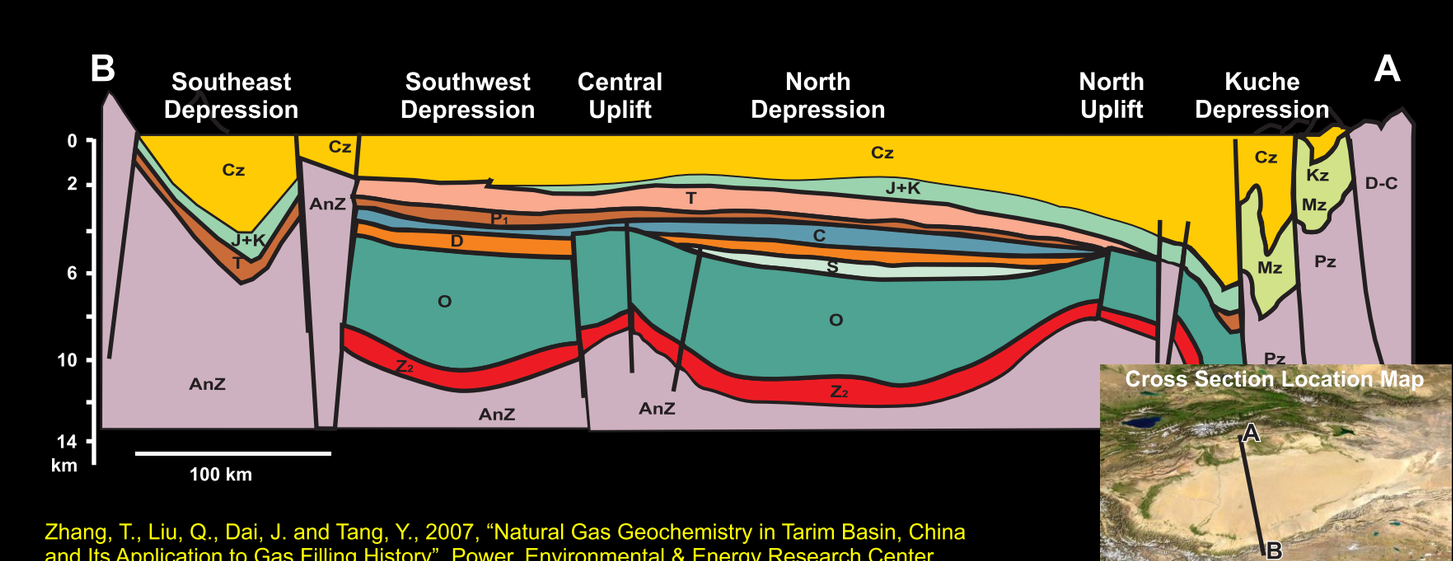
The Tarim Basin in China is similar to the Black Sea

It has no earthquakes. The geology around the Basin is the Himalayans which is radically different than the horizontal layers of sediments that are in the Tarim.



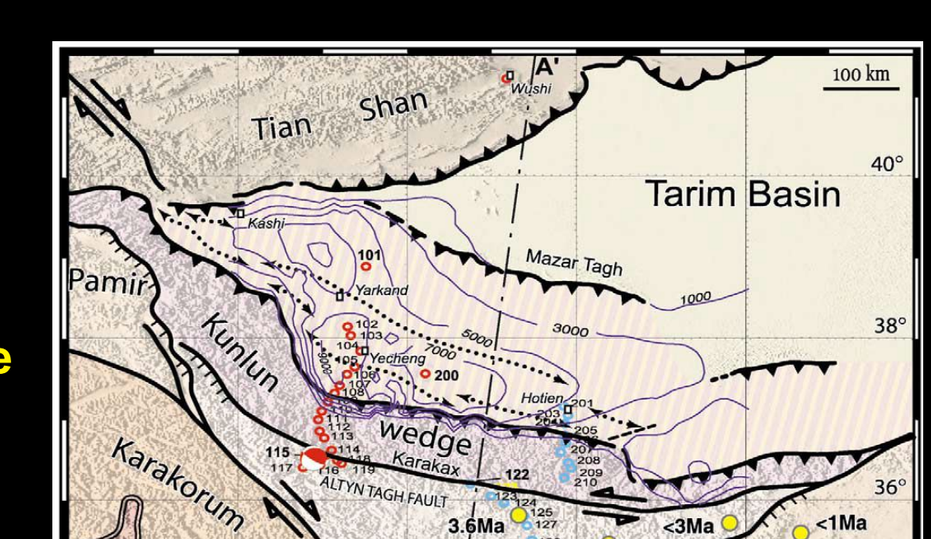
USGS - Seismicity of Asia, 1990 - 2000

Geological Cross Section of Tarim Basin: A deep hole filled with horizontal layers of sediments - the same as in the Black Sea, but with more tectonic compression. Note the depth of the sediments is 13 km deep.



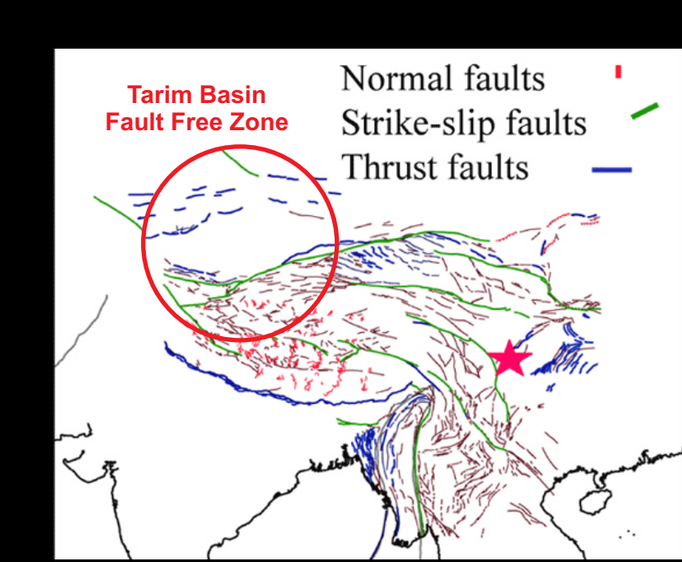
Zhang, T., Liu, Q., Dai, J. and Tang, Y., 2007, "Natural Gas Geochemistry in Tarim Basin, China and Its Application to Gas Filling History", Power, Environmental & Energy Research Center, Caltech; Research Institute of Petroleum Exploration and Development, PetroChina, Beijing 100083, China;

The edges of the thin oceanic crust of the Tarim Basin are causing compression in the thick continental crust around it.

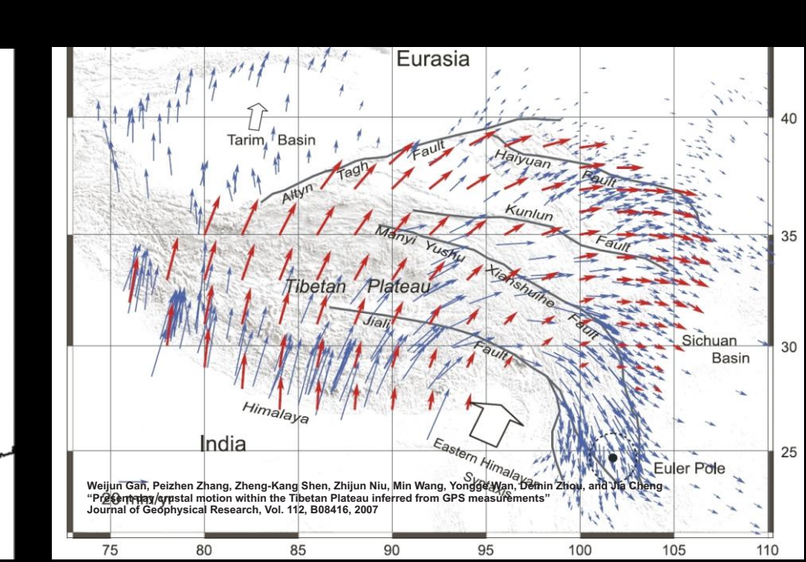


G. Wittlinger, J. Vergne, P. Tapponnier, V. Farra, G. Poupinet, M. Jiang, H .Sud, G. Herquel, A. Paul "Teleseismic imaging of subducting lithosphere and Moho ofsets beneath western Tibet" Earth and Planetary Science Letters 221 (2004) Pg. 117 - 130

The Tarim Basin has no significant Faults in it, The surrounding Himalayans have many fault zones. Tarim Basin GPS measurements are similar to those around the Black Sea: The Himalayan Mountains are being diverted around the thin crusted Tarim Basin.



Gao, X., Ma, X., Li, X., 2011, "The great triangular seismic region in eastern Asia: Thoughts on its dynamic context", Geoscience Frontiers, Vol. 2, Issue 1, Jan. 2011, Pg. 57-65



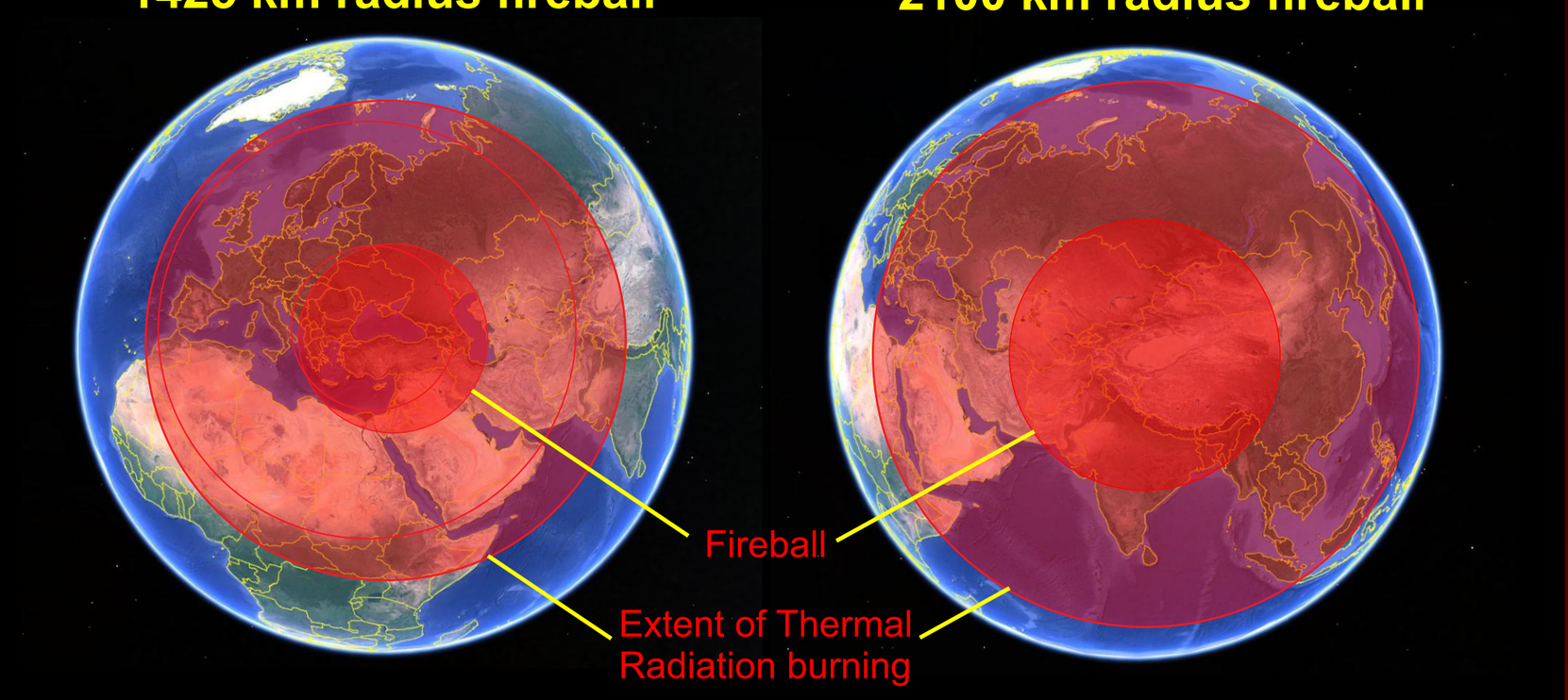
Gan, W., Zhang, P., Shen, Z., Niu, Z., Wang, M., Wan, Y., Zhou, D., and Cheng, J., 2007, "Present-day crustal motion within the Tibetan Plateau inferred from GPS measurements" Journal of Geophysical Research, Vol. 112, B08416

Large Comet Impacts would cause extinction events. Chicxulub is too small.

Extinction Events are caused by Comet Impacts

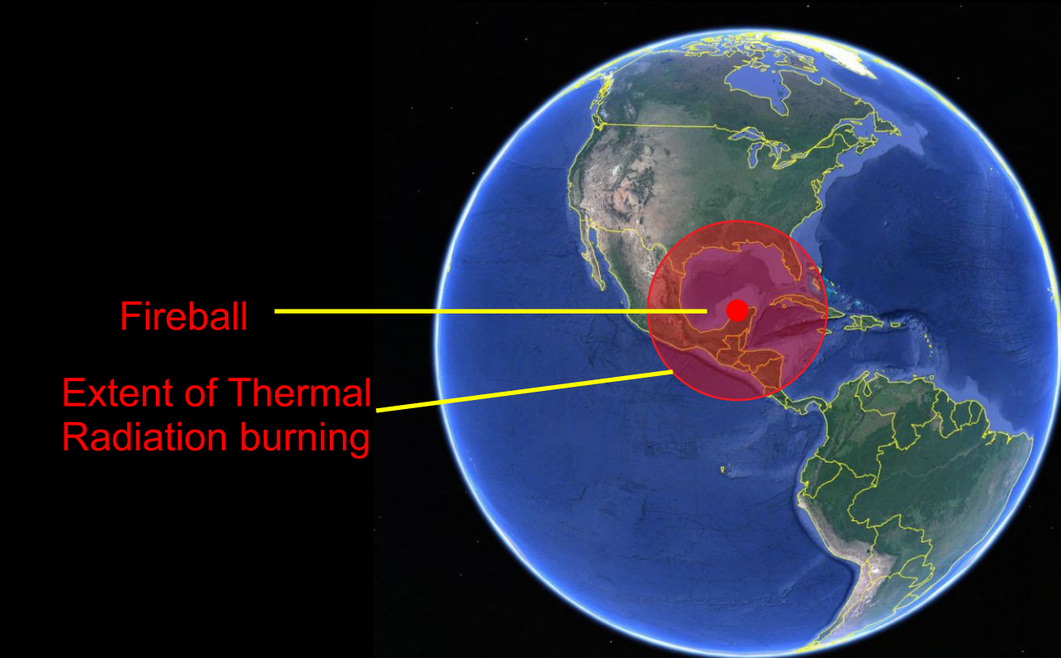
BLACK SEA IMPACTS:
65 km Comet, 42km/s
1425 km radius fireball

TARIM BASIN IMPACT:
95 km Comet, 42km/s
2100 km radius fireball

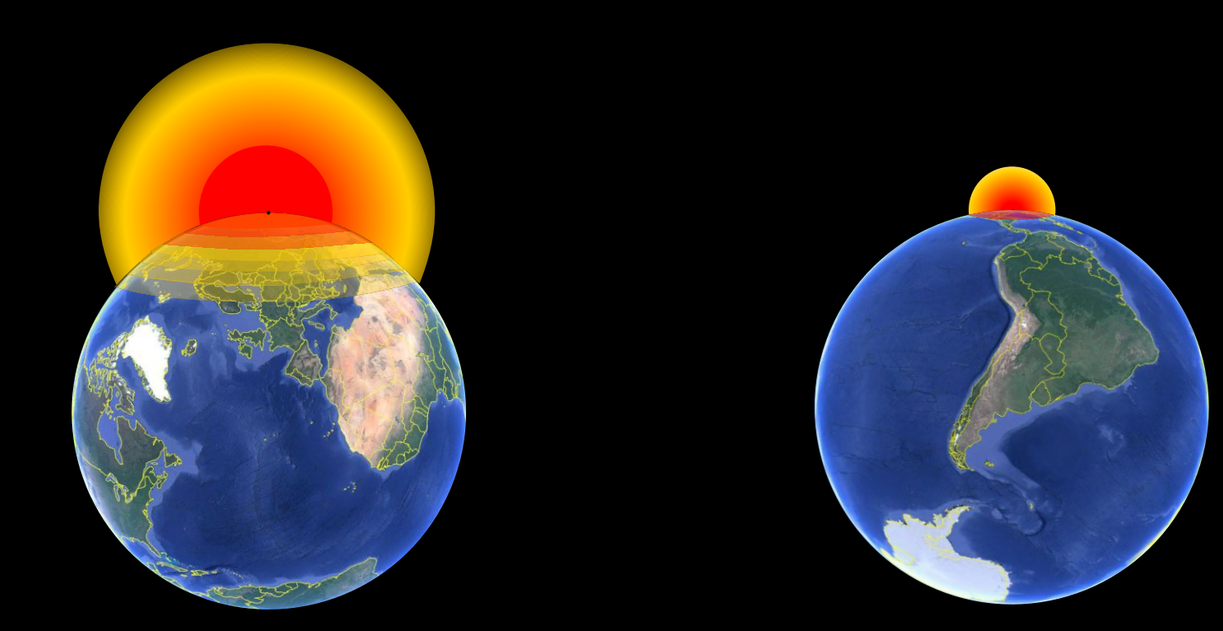


Planet Devasation events:
11 - 17% of the surface of Earth is burned
(58 M Km^2 / 510 M Km^2 for Black Sea, 88 M Km^2 / 510 M Km^2 for Tarim)

CHICXULUB IMPACT:
12 km Asteroid, 20 km/s impact
162 km radius fireball



A Small Local event:
1.0% of the surface of Earth is burned
(5.3 M Km^2 / 510 M Km^2)



Tarim Basin Impact
Thermal effect zone

Chicxulub Impact
Thermal effect zone

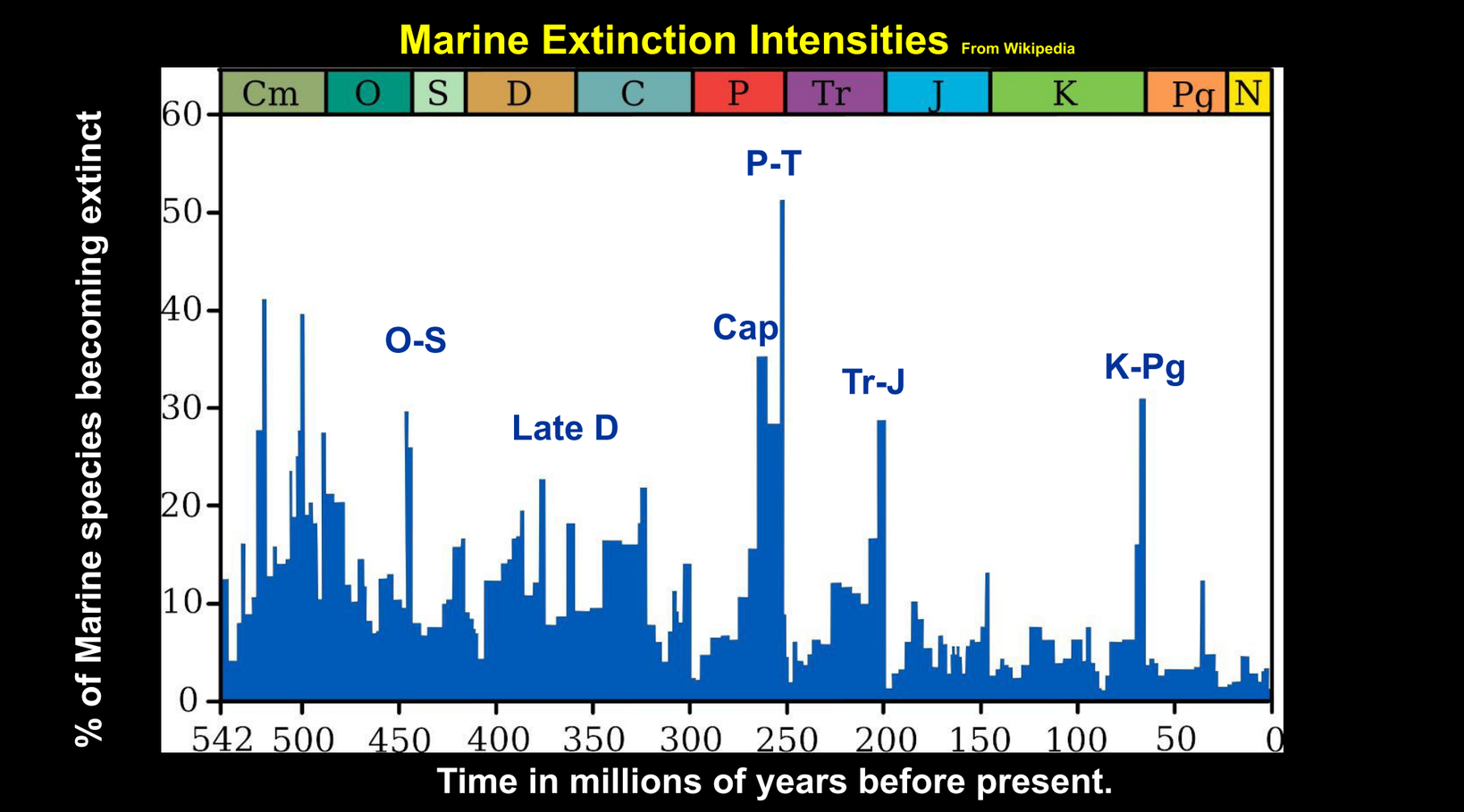
Asteroid Impact rates (1/100my) vs Comet Impact Rates (1/100ky)

Present impact frequency calculations are based on the recognized craters on Earth, and the calculations of asteroids hitting Earth.

With 1000 X as many objects in the Kuiper Belt, and with them 10 - 100 X larger than in the asteroid belt, we need to increase the frequency of very large impactors by at least 1000. Instead of a 10 km asteroid (Chicxulub) hitting once every 100 million years, we should expect a 10 km comet to hit once every 100,000 years and a 100 km comet to hit once every 10 million years. If we recognize large 23.4º features as craters, then the higher frequency of impacts fits.

Comet Craters Fit observed extinction rates

Extinction record shows extinction events are common

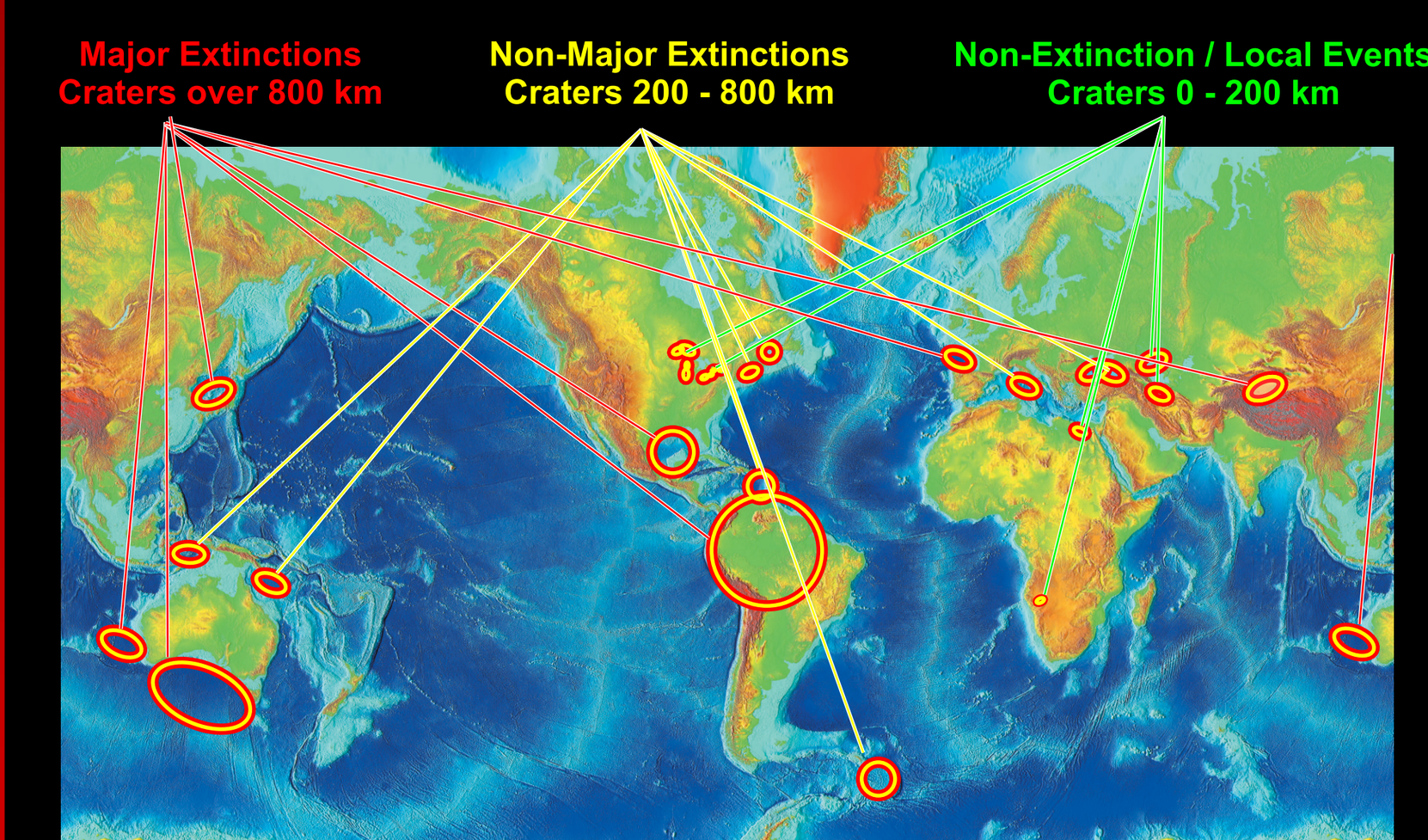


There are 6 major extinction events recognized, but the reality is that extinctions happen often. From the chart it seems that extinctions were much more frequent 500 million years ago. This fits comets reducing in frequency as time passes and less remain in orbit around the Sun. But millions still remain, and comet impacts must be much more frequent than present calculations imply.

Present understandings do not explain so many extinctions. If comet impacts are more frequent than presently believed, the extinctions become expected, not surprising.

If the Amazon Basin is an impact that led to the K/Pg event, then 100 - 400 km comet impacts lead to major extinctions. Smaller 30 - 100 km comet impacts suggested here would lead to lessor events, such as the events about 35, 150, 225, 320, ... million years ago.

Earth has many features at 23.4º and features at other angles or circular that range up to 3500 km diameter, that would lead to extinction events in themselves.



There are 20 large features oriented at 23.4º.
Since only a small percentage of craters are expected to be at 23.4º,
this implies that there must be many others not at 23.4º,
but that are as large or much larger.
This includes the Amazon Basin at 3500 km diameter.

Notes and comments

Fireball size calculations from the "Earth Impacts Effects Program"

Estimated Chicxulub Parameters:
Estimates are from the "Earth Impact Effects Program"
Robert Marcus, H. Jay Melosh, and Gareth Collins

Projectile Diameter: 12 km
Projectile Density: 3,000 kg/m^3
Impact Velocity: 20 km/s
Impact Angle: 90 degrees
Target Density: 2,700 kg/m^3

Crater: 154 km diameter
FIREBALL: 325 km diameter
Severe Thermal Radiation: 2,600 km diameter

Area covered by Fireball: .08 million km^2
Area covered by Severe Radiation: 5.3 million km^2
Portion of Earth effected: 5.3/510.1 = 1.0%

Estimated East Black Sea Parameters:
Estimates are from the "Earth Impact Effects Program"
Robert Marcus, H. Jay Melosh, and Gareth Collins

Projectile Diameter: 55 km
Projectile Density: 3000 kg/m^3
Impact Velocity: 41.7 km/s
Impact Angle: 15 degrees
Target Density: 2,700 kg/m^3

Crater: 591 km diameter
FIREBALL: 2,850 km diameter
Severe Thermal Radiation: 8,600 km diameter

Area covered by Fireball: 6.4 million km^2
Area covered by Severe Radiation: 58 million km^2
Portion of Earth effected: 58/510.1 = 11.4%

Estimated Tarim Basin Parameters:
Estimates are from the "Earth Impact Effects Program"
Robert Marcus, H. Jay Melosh, and Gareth Collins

Projectile Diameter: 95 km
Projectile Density: 3000 kg/m^3
Impact Velocity: 41.7 km/s
Impact Angle: 15 degrees
Target Density: 2,700 kg/m^3

Crater: 826 km diameter
FIREBALL: 4,200 km diameter
Severe Thermal Radiation: 10,600 km diameter

Area covered by Fireball: 13.8 million km^2
Area covered by Severe Radiation: 88 million km^2
Portion of Earth effected: 88/510.1 = 17.3%

NOTE: the diameter of Earth is 12,700 km, The circumference is 40,000 km

The fireball and radiation travel out from the impact, and can not effect areas blocked by the shadow of the planet. Therefore the effects can not exceed 1/2 of the planet, which is 10,000 km distance from impact. Also, the "Earth Impacts Effects Program" does not include curvature effects and does not calculate differences for low angle impacts.

Many Low Angle Impact Craters Implies many more Large Circular Craters

The Black Sea ellipses are 490X260 km and 630X340 km. The Tarim Basin is 880X450 km. These are 1:2 ratios, requiring very low angle impacts, approx. 15º - 20º.

15º - 20º impacts should be 5% of all impacts. Assuming these are caused by 15º - 20º impacts fits expected norms if there are 20 times as many circular craters of similar size. That such large circular craters exist is a separate topic, and has been previously been presented in the work on the Amazon Basin being viewed as a crater.
(Note: Probability of impact below angle ϴ is Sin (ϴ)^2)

Large, High Speed Comet Impacts will have ejecta sent to space at above escape velocities.

The energy of the impactor is transferred into an explosion that forms crater walls, and tosses out the material from the center of the crater as ejecta. Slower speed impacts have the majority of the ejecta fall back into the crater or spread out from the impact.

An impactor first penetrates the target at full speed until it is stopped by transferring its momentum into the target rock. This occurs in 1/2 to 3 X the diameter of the impactor depending on its density. Essentially it tosses its own mass back at its incoming speed, transferring its momentum to the ejecta and slowing as it does so. A small object traveling at asteroid impact speeds tosses very little back at initial speed. Most of the ejecta is sent out at below escape velocity.

The difference in these craters is that the impact speed is high enough that most of the ejecta is tossed back into space at higher than escape velocity. This leaves the transient crater holes as closer to the final depth of the crater than for slower impacts. An impacting comet traveling at 41.7 km/s relative to Earth will toss at least 3/4 its mass as ejecta back into space at above escape velocity.

Predictions based on comet impacts solve most Plate Tectonic questions

The ultimate test of a theory in Science is how well it predicts unexpected findings. Frequent, large impacts predict that Extinctions are caused by impacts without need of global warming side effects or higher than average volcanism. Traps become expected results of shock waves traveling through Earth instead of surprising unknowns. Giant tsunami patterns on Pacific coasts are expected. The Black Sea and Tarim Basin features are expected instead of mysterious. Adding large and frequent comet impacts to Plate Tectonics solves every unexplainable feature tested to date.

Shock Metamorphic Effects will be difficult to find in high speed Comet Impacts

Craters are proven by shock metamorphic evidence as typically found with asteroid impacts. High speed impacts will typically toss away the surface ejecta, so minimal shocked material will remain in the crater. With high speeds, the zone of shock effects is much narrower: the comet has passed through the lithosphere tossing away the shocked rock before the shock can travel farther. So there will be a very narrow zone of shock metamorphic evidence in the crater walls, and minimal to none in the crater itself.

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