
Asteroid Impacts
©Don Davis

ASTEROID

ASTEROID

Farbe, USA 1997, 90 Min.

Bradford May. Drehbuch: **Robbyn Burger und Scott Sturgeon**. Musik: **Shir-alker**. Kamera: **Thomas Del Ruth, David A. Hennings**. Visuelle Effekte: **Sam lson**. Produzent: **John Davis**.

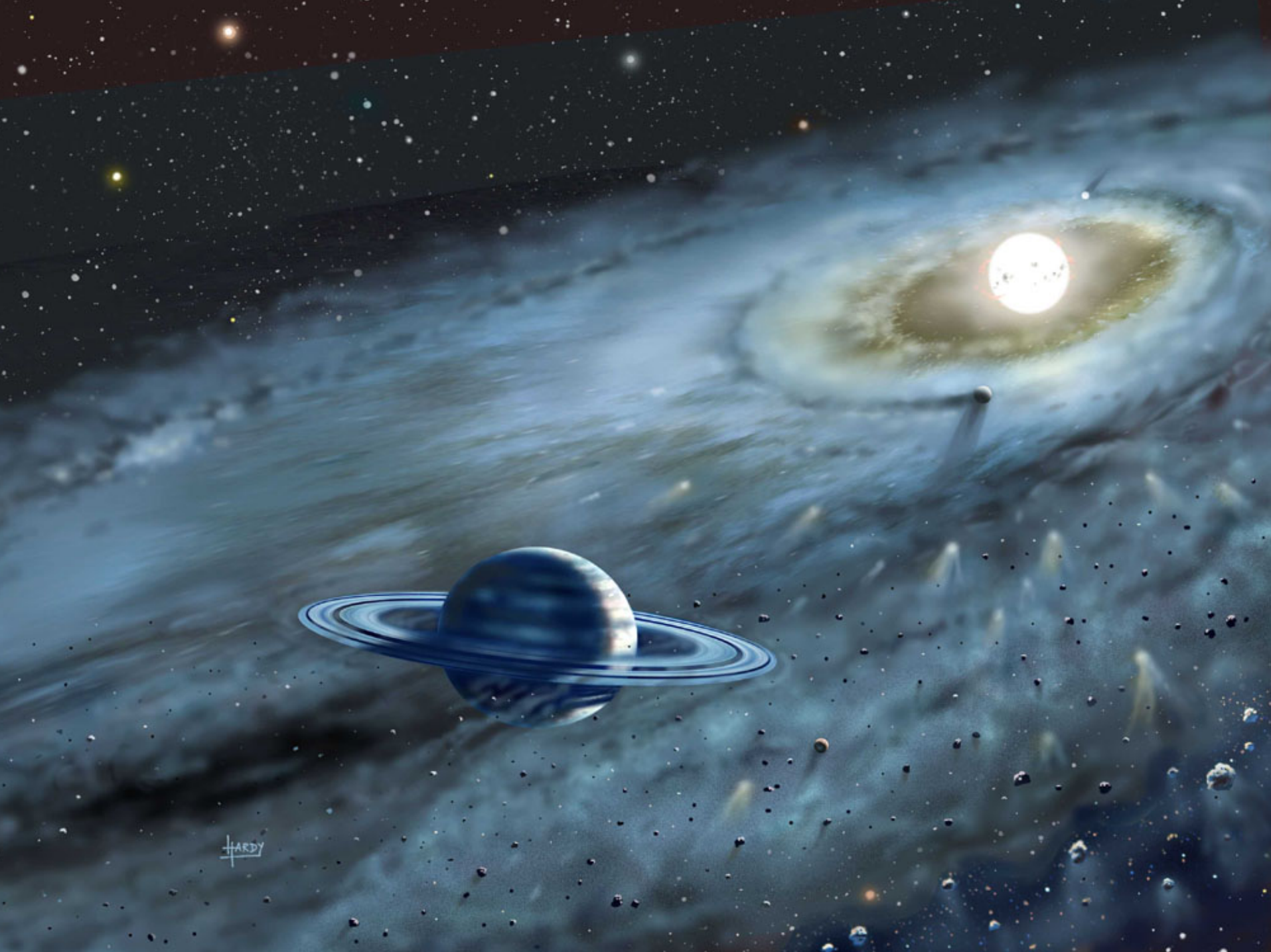
eller: Michael Biehn (Jack Wallach), **Annabella Sciorra** (Dr. Lily McKee), **Don lin** (Ben Dodd), **Zachary Charles** (Elliot McKee), **Anthony Zerbe** (Dr. Charles Na-**Brian Allen-Hill** (Max Jensen), **Michael Weatherly** (. Matthew Rogers), **Jensen tt** (Valerie Brennan), **Denis Arndt** (Präsident), **Carlos Gómez** (Adam Marquez), **Marie Johnson** (Keren Dodd)

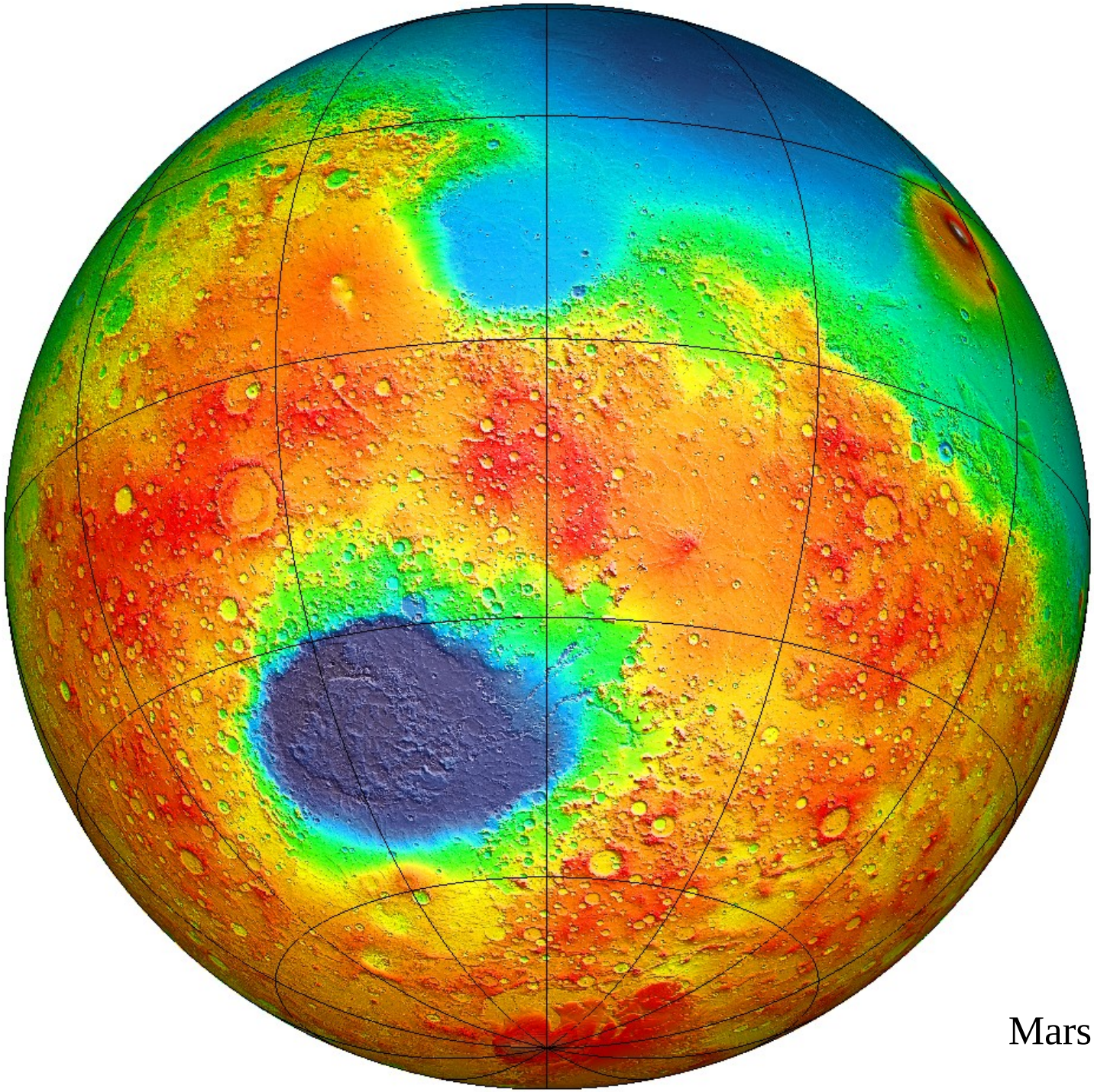
stronomin Dr. Lily McKee entdeckt, daß in wenigen Tagen ein oid in der Nähe von Kansas City einschlagen wird. Sie informiert Chef der amerikanischen Katastrophenschutzbehörde, Jack Wal-über die bevorstehende Gefahr, der mit seinen Mitarbeitern den ver-elten Versuch macht, die Millionenstadt zu evakuieren. Als der Ko-einschlägt, kommt es zum Dammbruch, der eine Flutwelle auslöst, ch bis nach Kansas City ergießt. Dort versucht der Feuerwehrmann Dodd mit seinen Männern zu retten, was zu retten ist und gerät da-lbst in Lebensgefahr. Damit nicht genug: Lily entdeckt, daß ein wei-Asteroid Kurs auf die Erde nimmt. Dieser noch größere Himmels-r droht vor der Küste Japans einzuschlagen und bedroht das Le-on Millionen Menschen.

SCIENCE FICTION

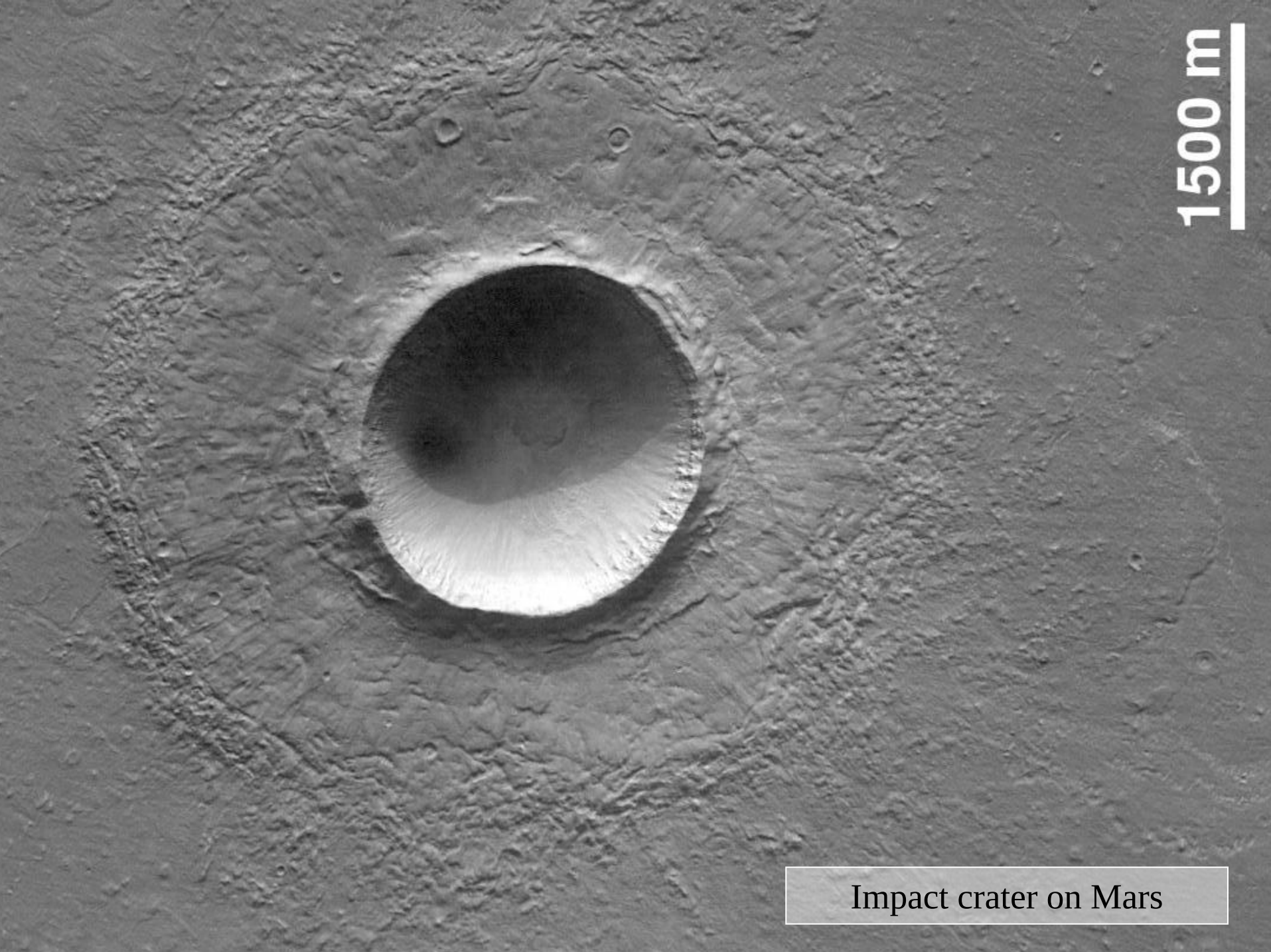
ASTEROID

ASTEROID


HARDY



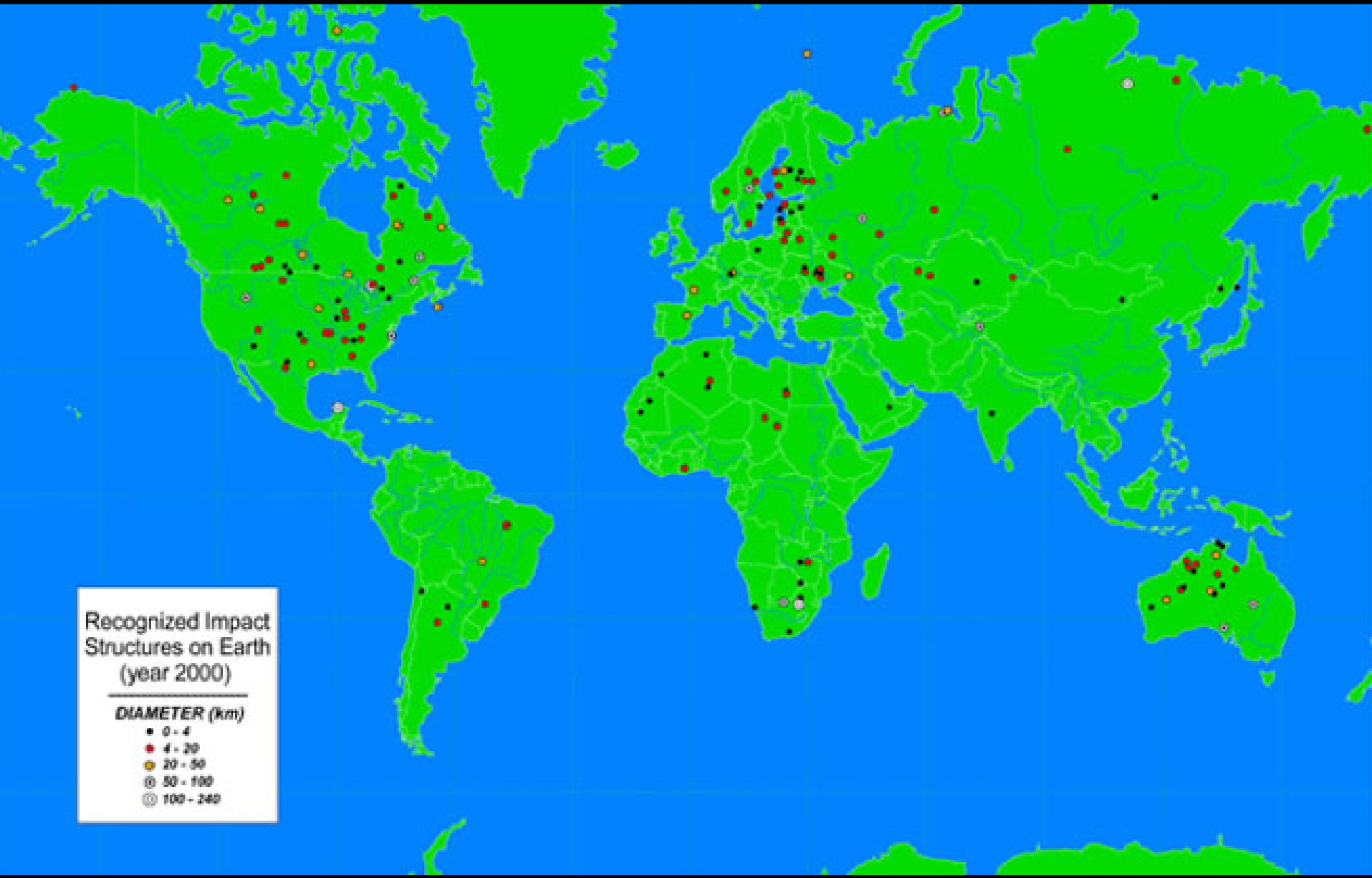
Mars



Impact crater on Mars


Impact craters on theMoon

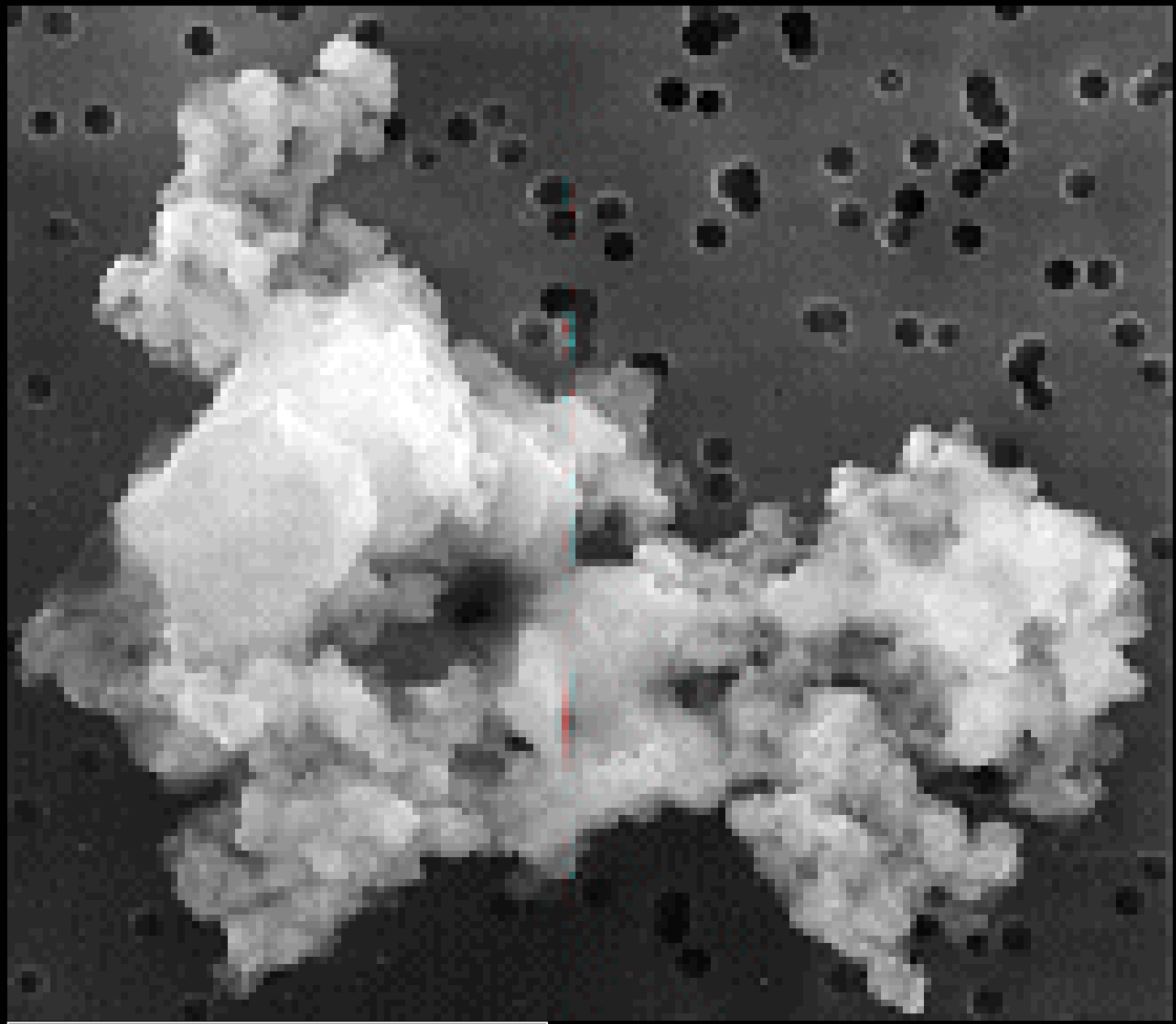
Impact craters on the Moon


Recognized Impact Structures on Earth (year 2000)
DIAMETER (km)
0 - 4
4 - 20
20 - 50
50 - 100
100 - 240

Meteor hitting atmosphere

Leonid meteor swarm

Meteor hitting South Greenland 1997



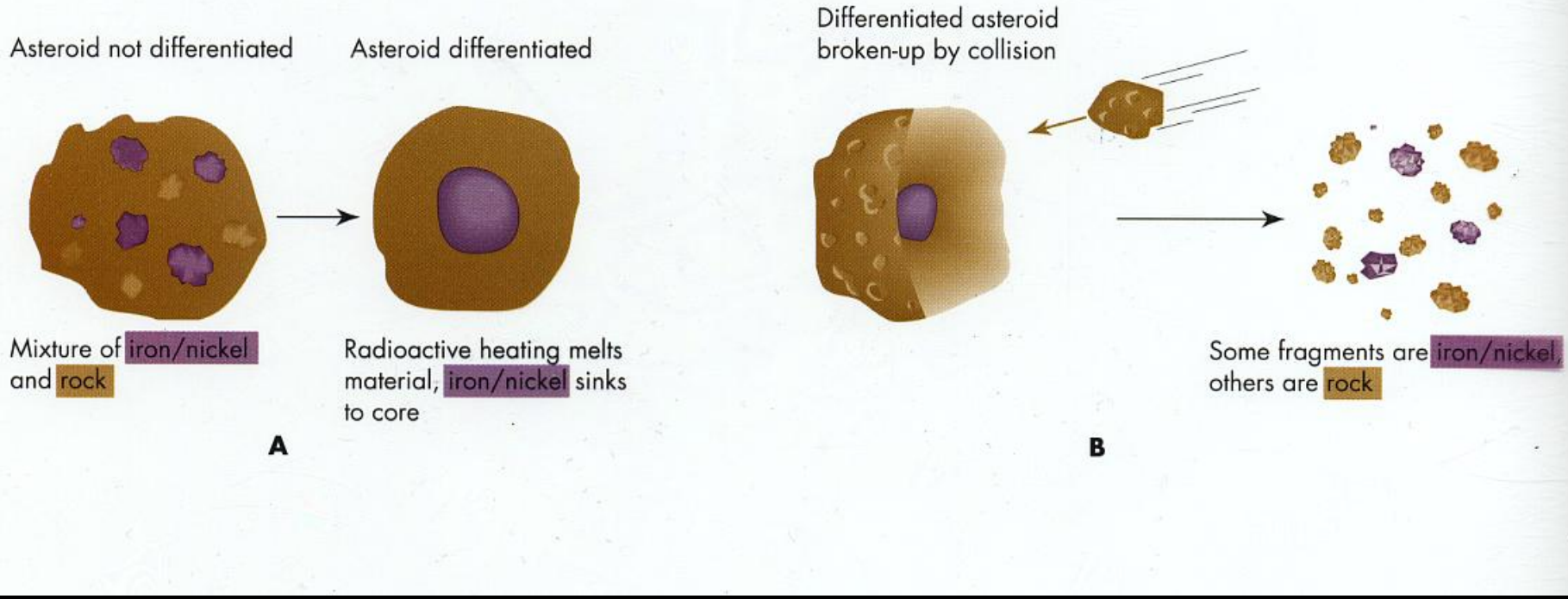
Meteor dust, 0.01 mm

Meteorite find in Sahara

Meteorite find in the Antarctic

Iron meteorite, 5 cm

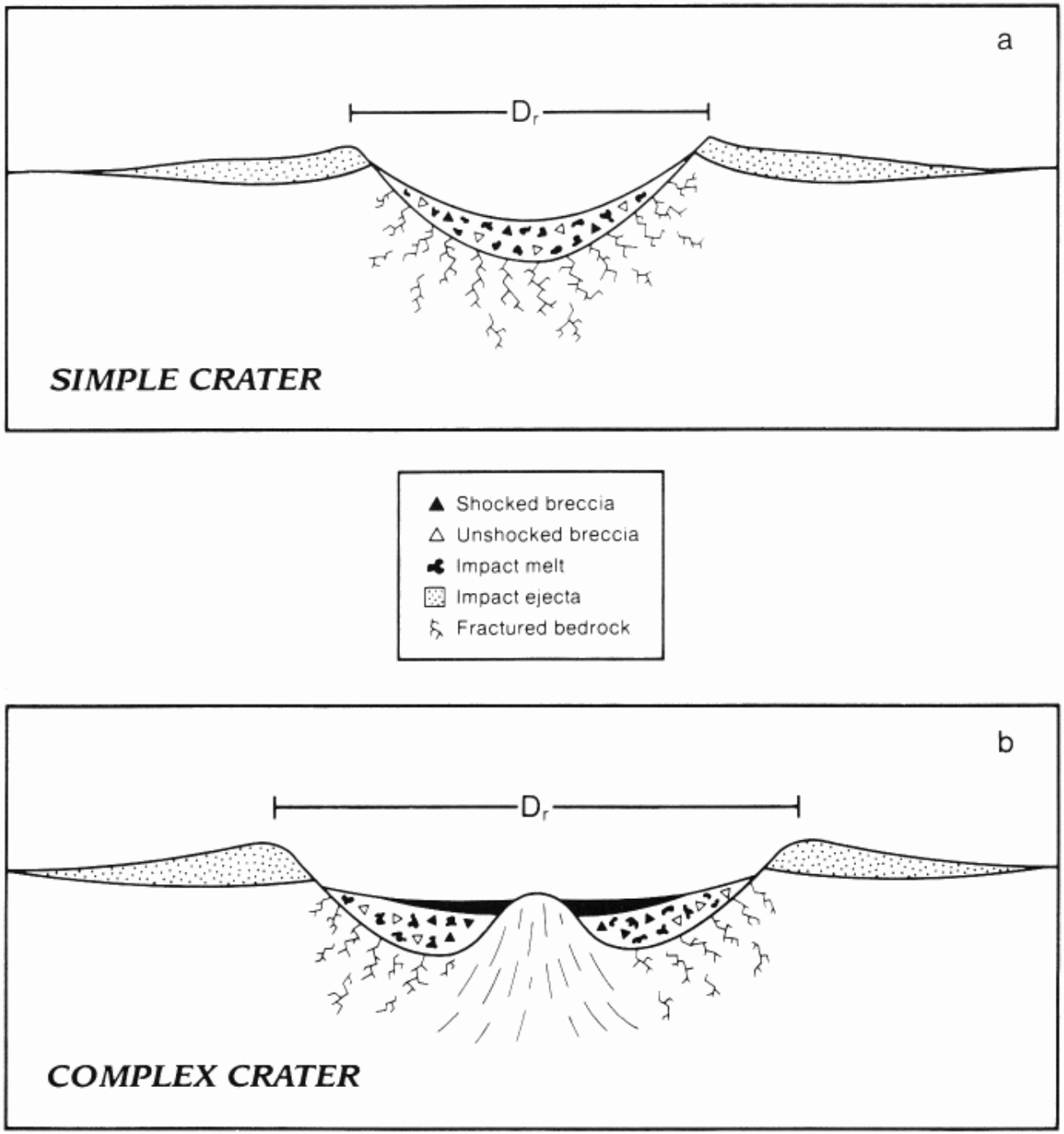
Stone meteorite, 8 cm


Asteroid not differentiated
Asteroid differentiated
Mixture of iron/nickel and rock
Radioactive heating melts material, iron/nickel sinks to core
A
Differentiated asteroid broken-up by collision
Some fragments are iron/nickel, others are rock
B

Asteroid, 17 km


Asteroid surface, 700 m visible

Barringer Meteor Crater, Arizona. 1.2 km diameter. Age: 49000 BP

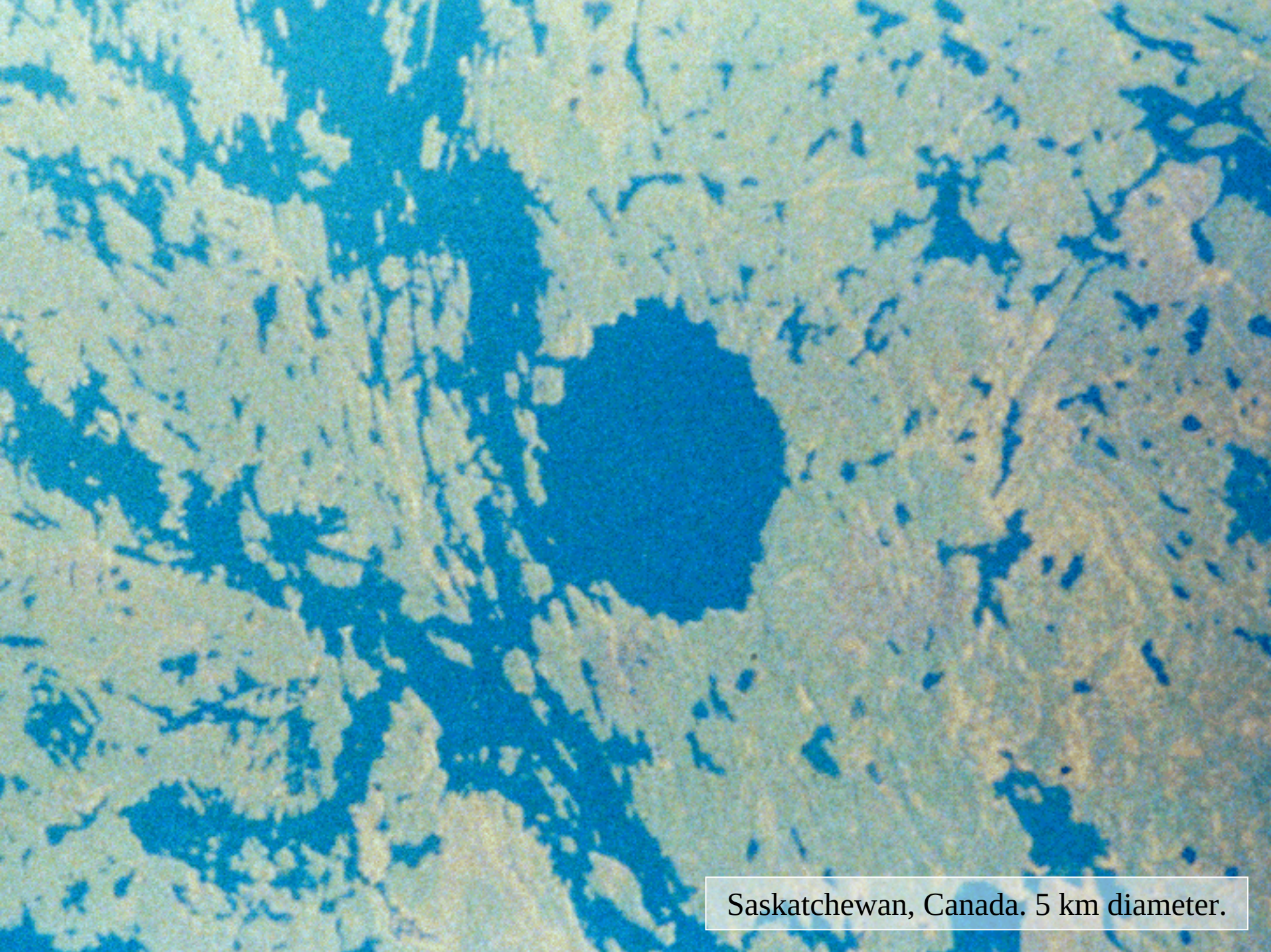

a
D_r
SIMPLE CRATER
Shocked breccia
Unshocked breccia
Impact melt
Impact ejecta
Fractured bedrock
b
D_r
COMPLEX CRATER


N
W
E
S
Image © 2005 DigitalGlobe
© 2005 Google
Pointer lat -25.365159° lon 131.035700° elev 523 m
Streaming 100%
Eye alt 17.25 k

Ayers rock Australia

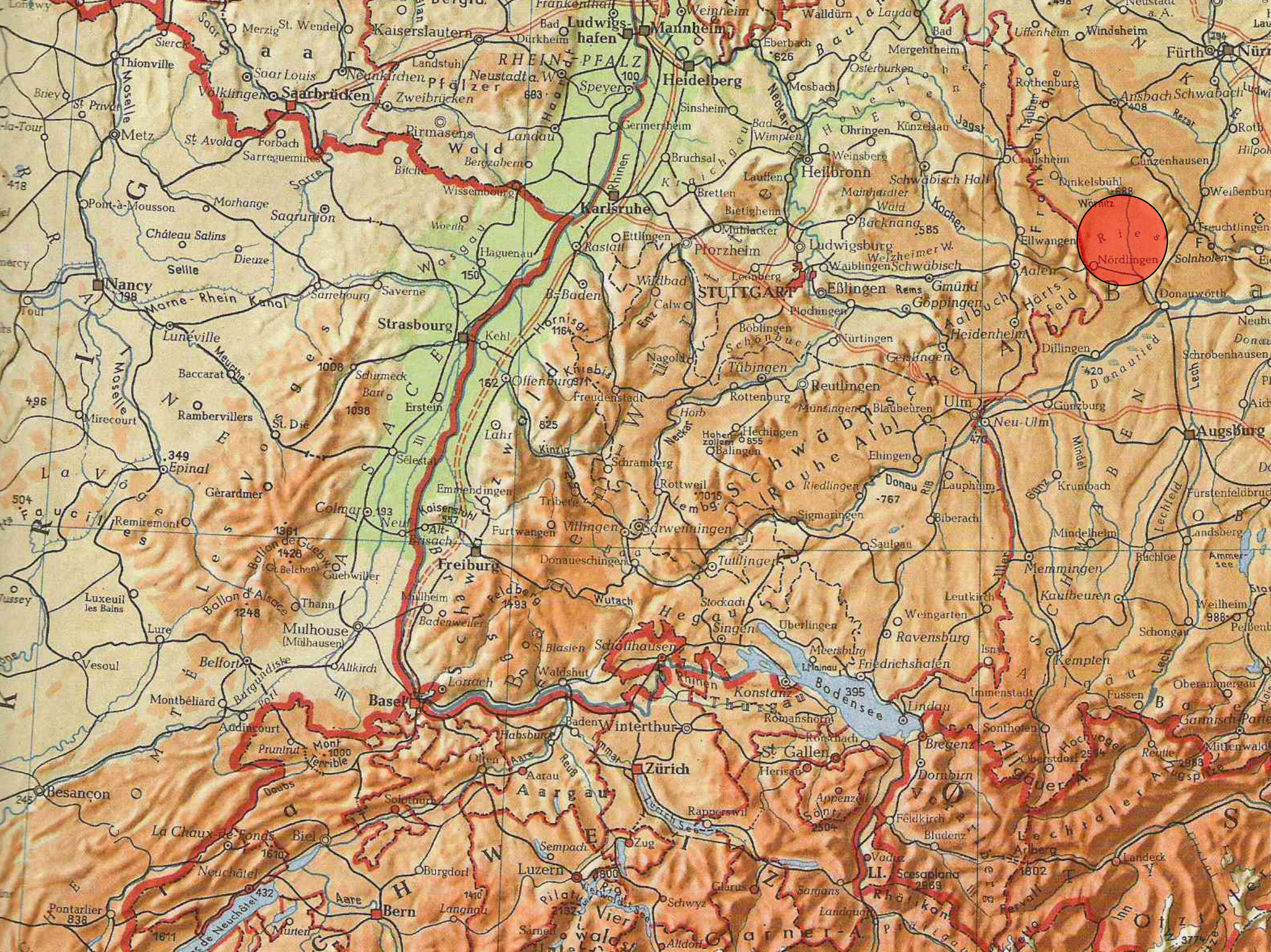
Wolfe Creek Crater, Australia. 0.9 km diameter. Age: 300,000 BP


N
W
E
S
Image © 2005 MDA EarthSat
© 2005 Google
Pointer lat 48.933017° lon -66.966597° elev 208 m
Streaming 100%
Eye alt 628.47

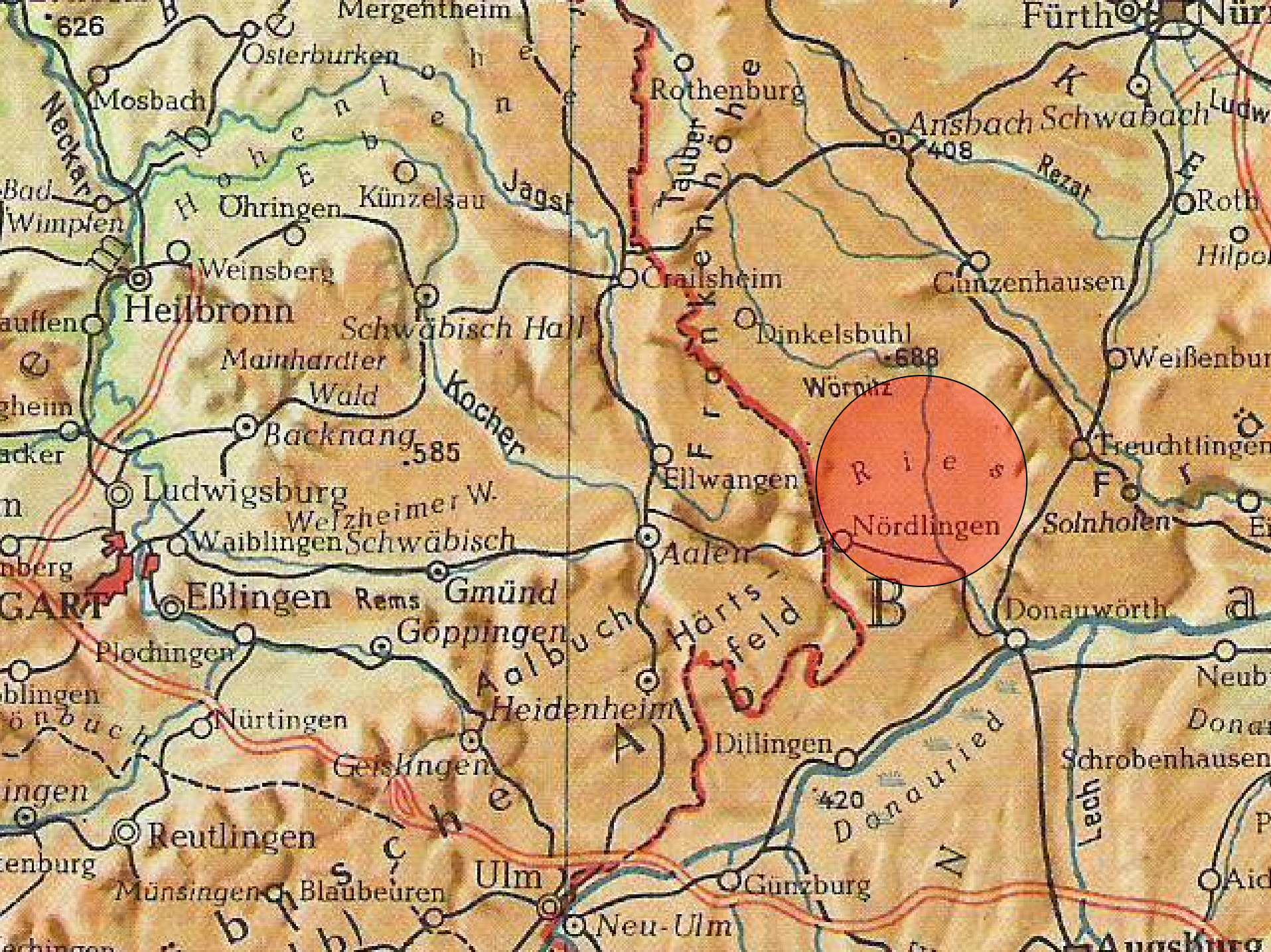


Saskatchewan, Canada. 5 km diameter.

Chad, Africa. 10 km diameter.



Kaiserslautern
Ludwigshafen
Mannheim
Weinheim
Heidelberg
RHEIN-PFALZ
Pfälzer Wald
Saarbrücken
Saar Louis
Völklingen
Neunkirchen
Zweibrücken
Pirmasens
Landau
Speyer
Germersheim
Metz
Thionville
Forbach
Sarreguemines
St. Avold
Bitche
Wissembourg
Bergzabern
Karlsruhe
Bruchsal
Sinsheim
Eberbach
Mosbach
Heilbronn
Weinsberg
Öhringen
Künzelsau
Schwäbisch Hall
Crailsheim
Rothenburg
Ansbach
Schwabach
Fürth
Windsheim
Gunzenhausen
Dinkelsbühl
Weißenburg
Treuchtlingen
Ries
Nördlingen
Wörnitz
Ellwangen
Aalen
Solnhofen
Donauwörth
Pont-à-Mousson
Château Salins
Dieuze
Nancy
Lunéville
Sarrebourg
Saverne
Haguenau
Strasbourg
Kehl
Ettlingen
Rastatt
B.-Baden
Pforzheim
Bretten
Mühlacker
Bietigheim
Ludwigsburg
Backnang
Waiblingen
Schwäbisch Gmünd
Welzheimer W.
STUTTGART
Eßlingen
Plochingen
Göppingen
Heidenheim
Härtsfeld
Leonberg
Calw
Wildbad
Böblingen
Schönbuch
Nagold
Tübingen
Nürtingen
Geislingen
Reutlingen
Rottenburg
Münsingen
Blaubeuren
Ulm
Neu-Ulm
Dillingen
Günzburg
Augsburg
Hechingen
Balingen
Schwäbische Alb (Rauhe Alb)
Ehingen
Riedlingen
Lauphelm
Biberach
Sigmaringen
Saulgau
Rottweil
Schramberg
Schwenningen
Villingen
Tuttlingen
Donaueschingen
Freudenstadt
Offenburg
Lahr
Emmendingen
Triberg
Furtwangen
Freiburg
Feldberg 1493
Müllheim
Badenweiler
St. Blasien
Waldshut
Lörrach
Basel
Schaffhausen
Singen
Hegau
Stockach
Überlingen
Meersburg
Friedrichshafen
Ravensburg
Weingarten
Bodensee 395
Konstanz
Romanshorn
Lindau
Bregenz
Dornbirn
Feldkirch
Bludenz
Vaduz
Kempten
Memmingen
Kaufbeuren
Mindelheim
Buchloe
Landsberg
Füssen
Oberammergau
Garmisch-Partenkirchen
Zugspitze
Sonthofen
Immenstadt
Oberstdorf
Allgäuer A.
Lechtaler A.
Arlberg
Landeck
Épinal
Mirecourt
Rambervillers
Baccarat
St. Dié
Gérardmer
Remiremont
Colmar
Sélestat
Erstein
Mulhouse (Mülhausen)
Guebwiller
Thann
Ballon d'Alsace 1248
Luxeuil les Bains
Lure
Vesoul
Belfort
Altkirch
Montbéliard
Audincourt
Besançon
La Chaux-de-Fonds
Biel
Neuchâtel
Pontarlier
Bern
Burgdorf
Luzern
Zug
Zürich
Winterthur
Baden
Aarau
Aargau
Olten
Solothurn
St. Gallen
Appenzell
Rapperswil
Schwyz
Glarus
Sargans


626
Mergentheim
Osterburken
Mosbach
Neckar
Rothenburg
Fürth
Ansbach
Schwabach
408
Rezat
Roth
Bad
Wimpfen
Ohringen
Künzelsau
Jagst
Tauber
Crailsheim
Gunzenhausen
Weinsberg
Heilbronn
Schwäbisch Hall
Mainhardter
Wald
Kocher
Blinkelsbühl
688
Wörnitz
Weißenburg
Backnang
585
Ellwangen
Ries
Treuchtlingen
Ludwigsburg
Welzheimer W.
Waiblingen
Schwäbisch
Nördlingen
Solnhofen
Aalen
Eßlingen
Rems
Gmünd
Donauwörth
Göppingen
Plochingen
Härtsfeld
Albuch
Heidenheim
Nürtingen
Dillingen
Schrobenhausen
Geislingen
420
Donauried
Lech
Reutlingen
Münsingen
Blaubeuren
Ulm
Günzburg
Neu-Ulm


N
W
E
S
Image © 2006 MDA EarthSat
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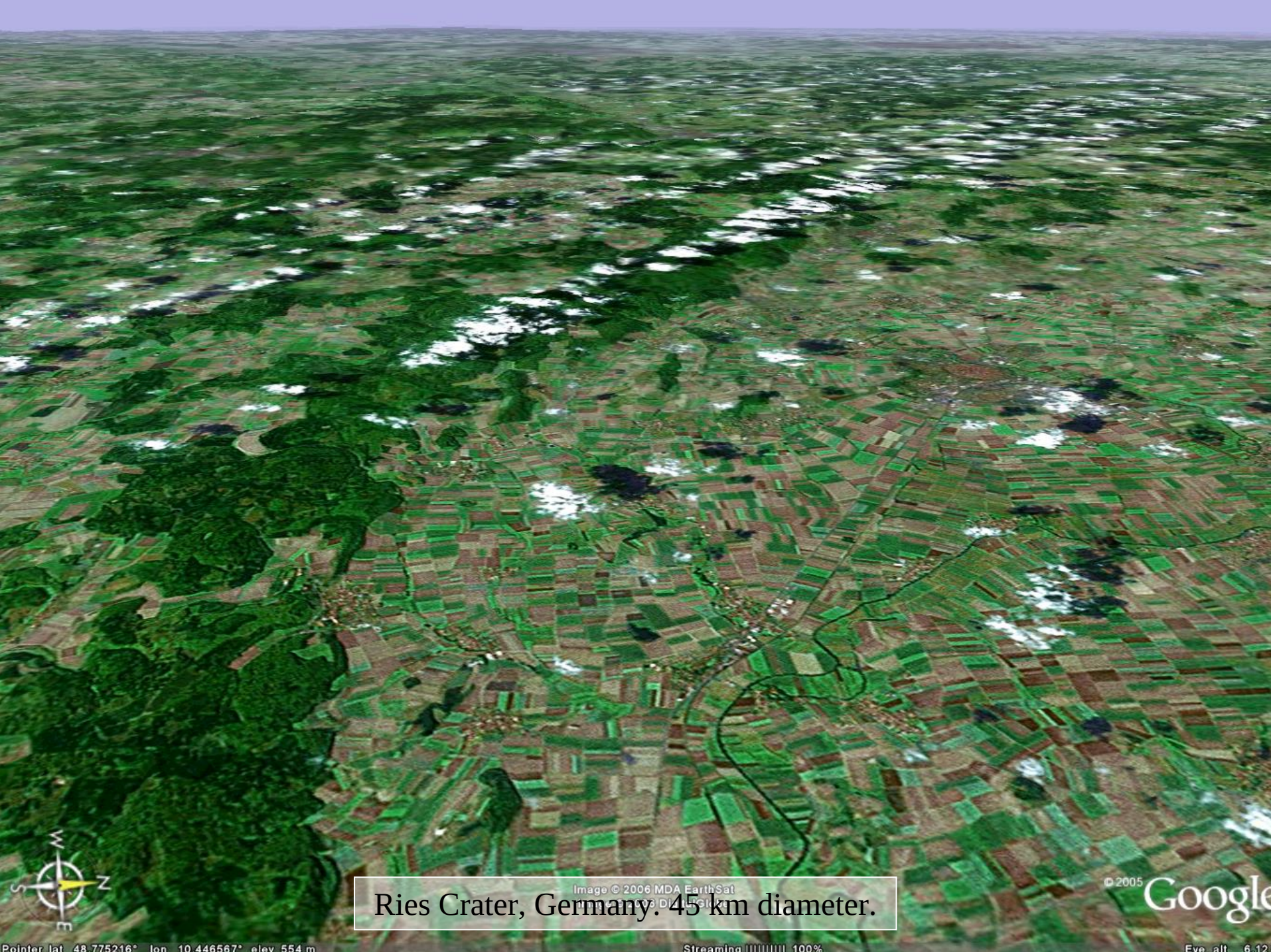


Ries Crater, Germany. 45 km diameter.

Nördlinger Riis crater rim

Nördlinger Riis Tectite

Earth and Moon

Young planet Earth collides with large asteroid ?

Asteroid hits Earth 65 mill yr BP

Recent asteroid impacts with the Earth

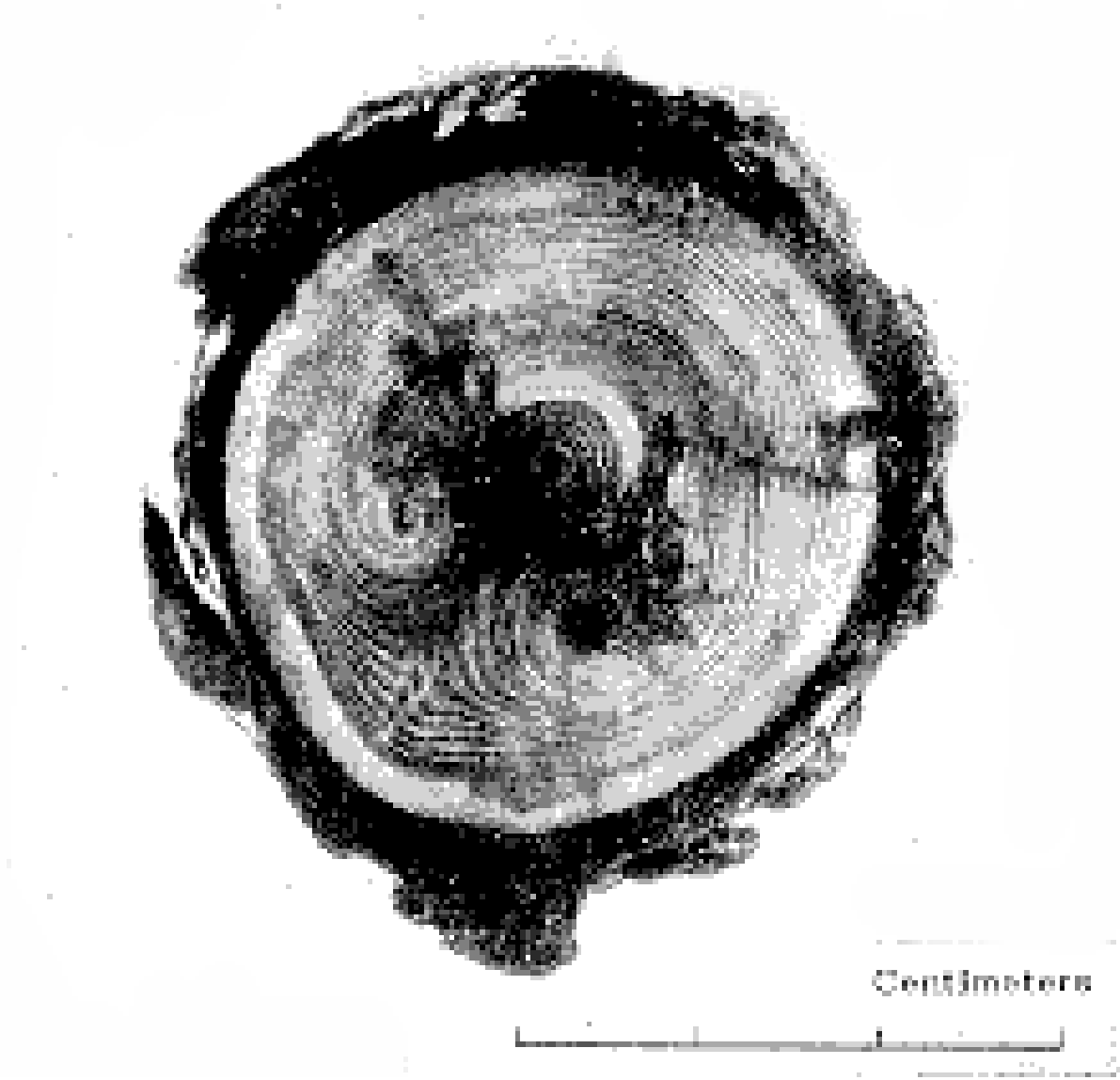
Stony asteroids with a diameter less than about 100 metres generally do not reach the Earth's surface. These objects usually explode several kilometres above the surface (an "airburst").

This was probably the case with the "Tunguska" Siberian event in 1908. The kinetic energy involved is substantial - a typical impact by a 50m object releases about 10 megatons of TNT and that of a 100m object releases about 75 Mt (the actual kinetic energy depends on several factors such as speed and density and can vary by a factor of more than 10). These explosions are equivalent in energy to large thermonuclear explosions and they can cause devastation over thousands of square kilometres - in the case of Tunguska the area of destruction was about 2,000 sq km or a circle of radius 25km. Fortunately the region was sparsely populated and had little effect on humans.

"Tunguska" Siberian event in 1908

"Tunguska" Siberian event in 1908, trees destroyed within 2,000 km2 area.

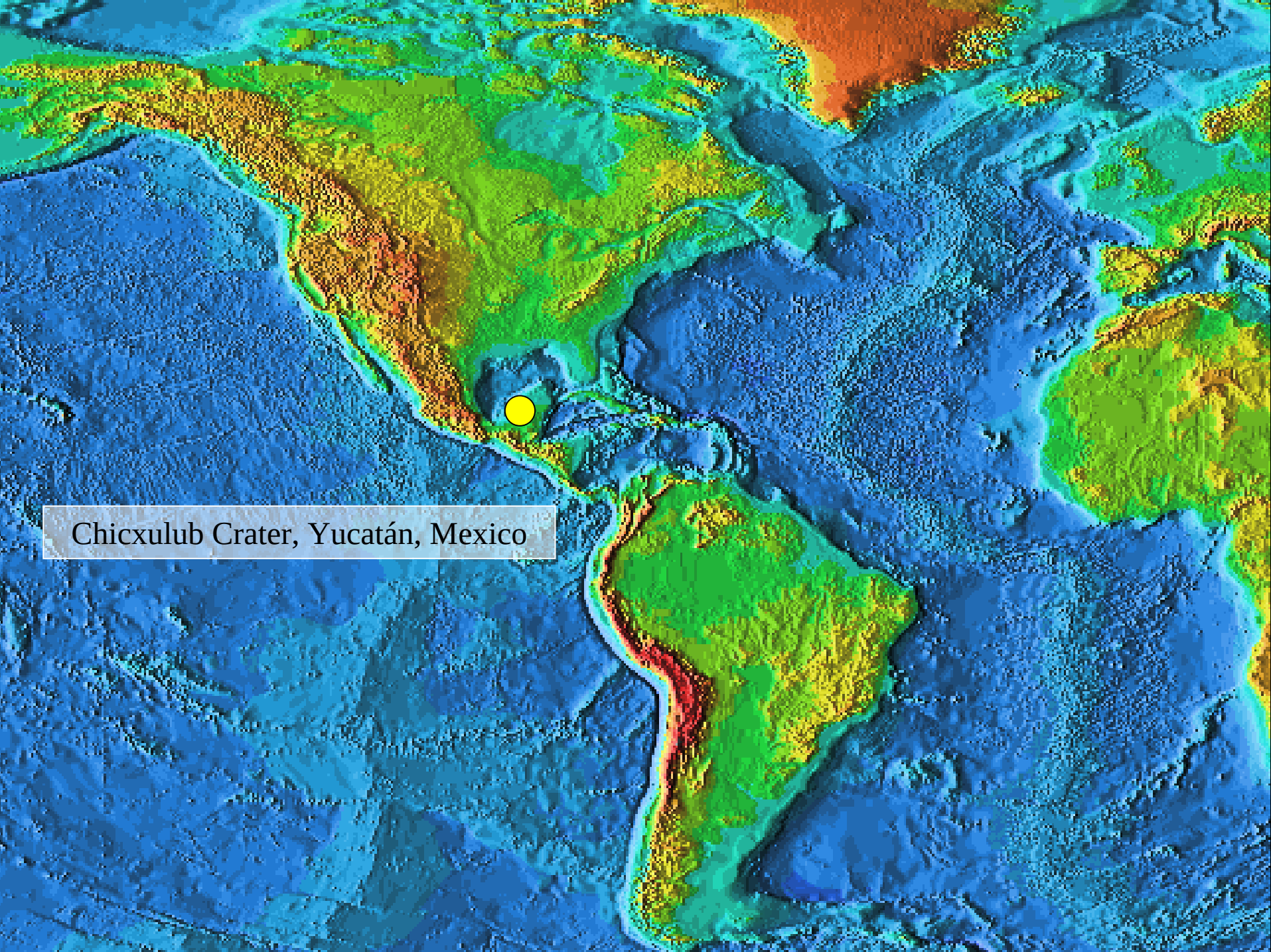
Фото IV. Современный вид одного из участков Куликовского вывала.
Видны повалившиеся и сломанные у корня деревья.

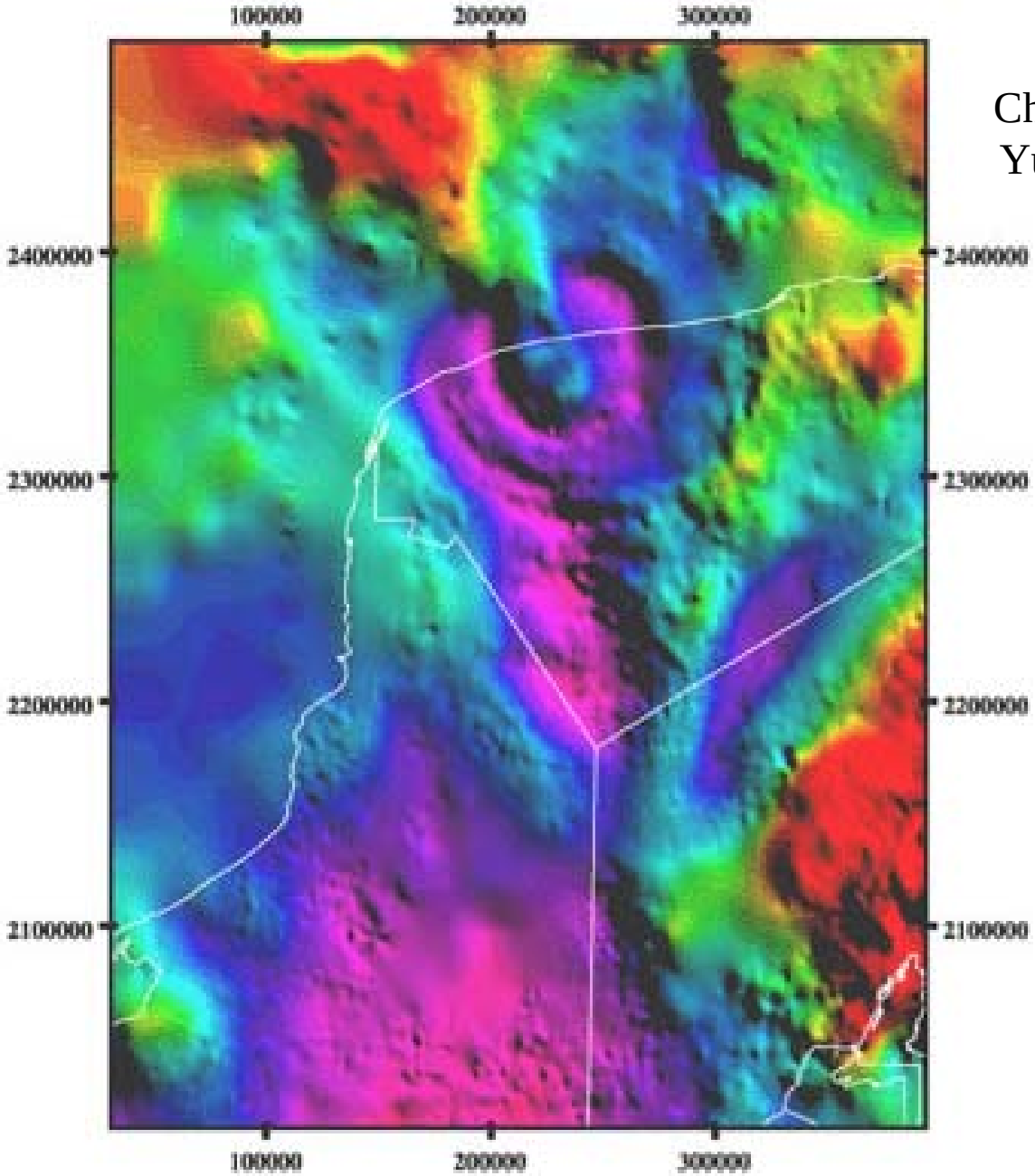


Tree rings recording "Tunguska" Siberian event in 1908

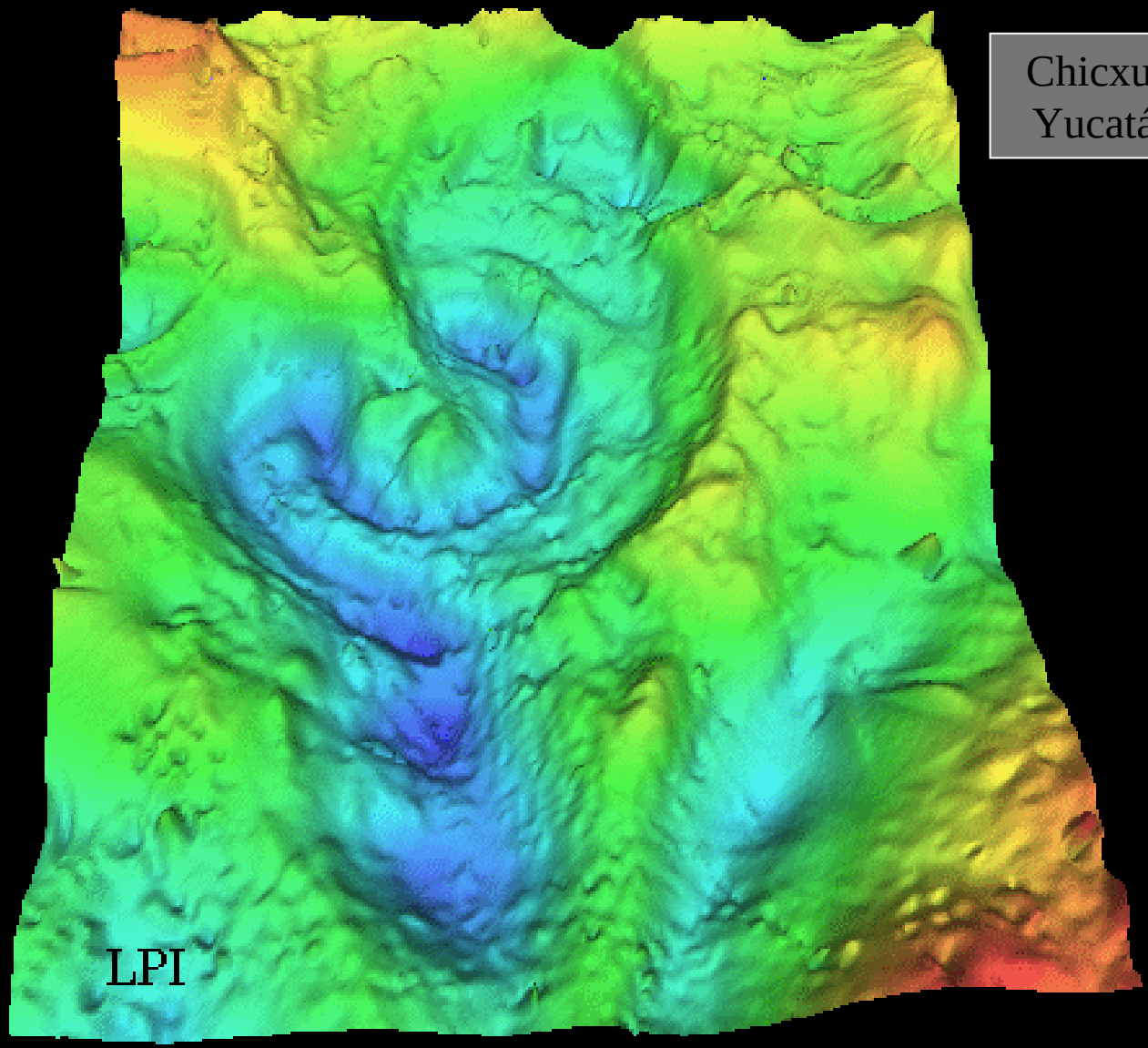
Climate change

Asteroid hits Earth 65 mill yr BP

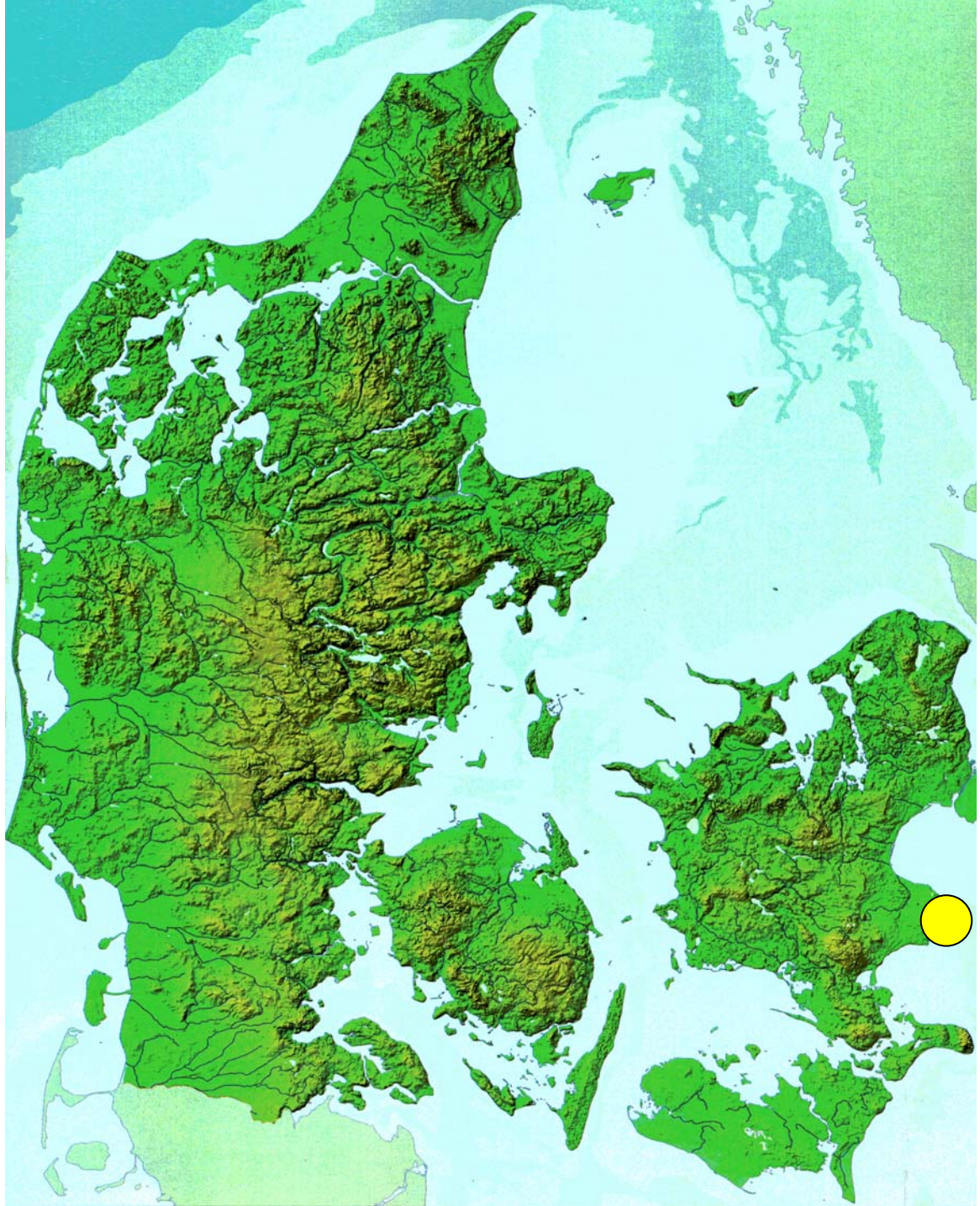

Chicxulub Crater, Yucatán, Mexico



Chicxulub Crater,
Yucatán, Mexico



Chicxulub Crater,
Yucatán, Mexico

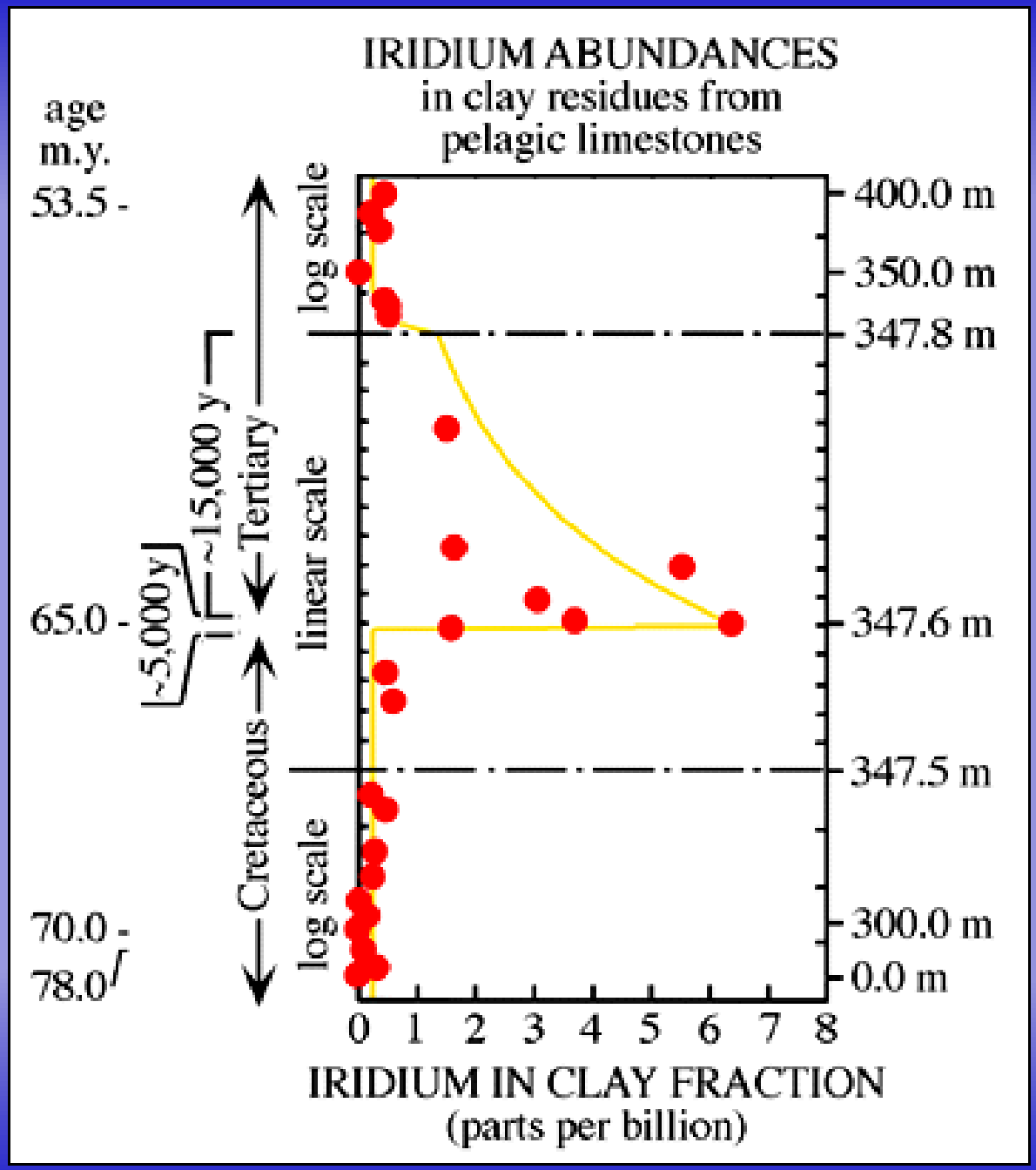


Stevns,

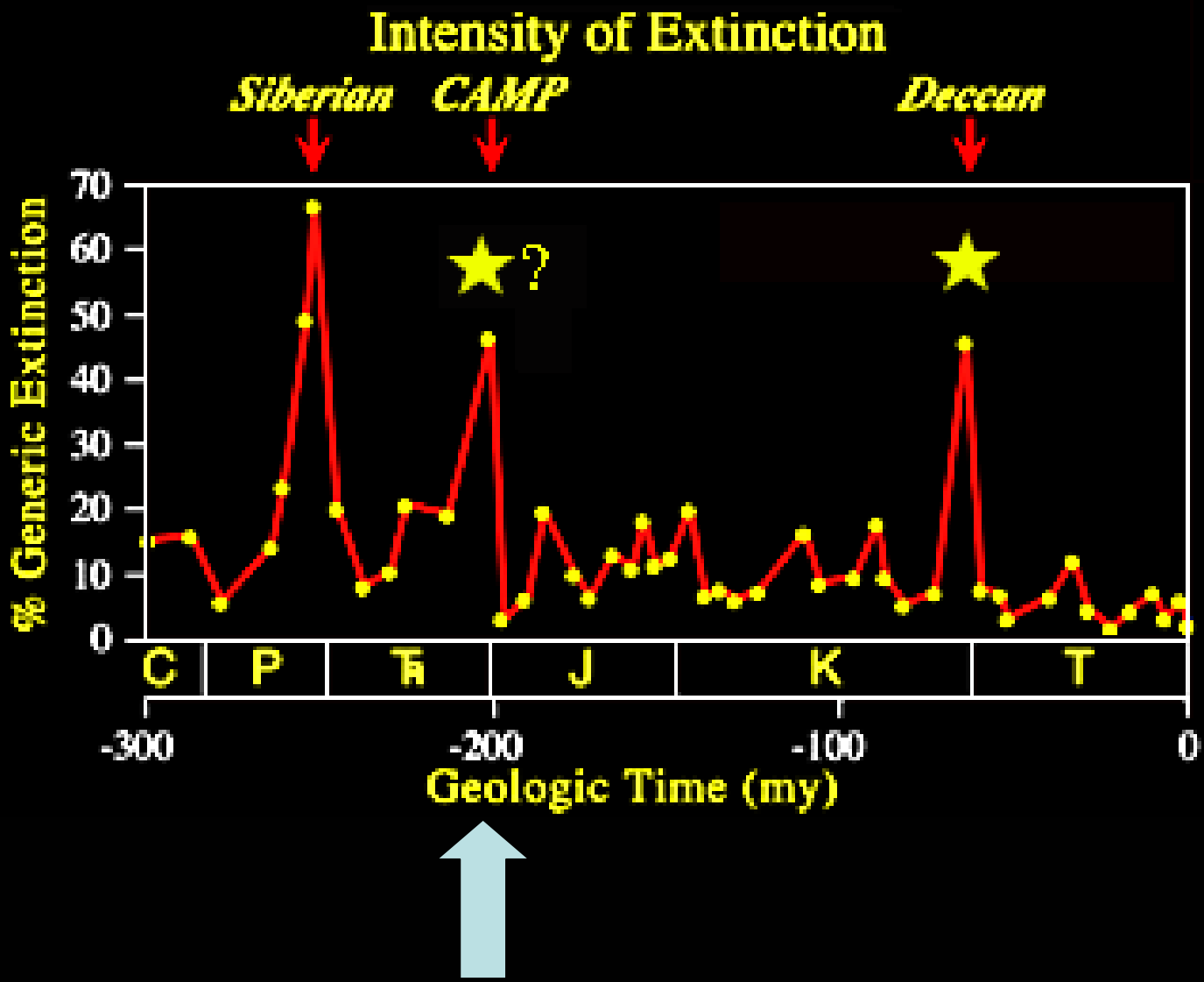
Denmark

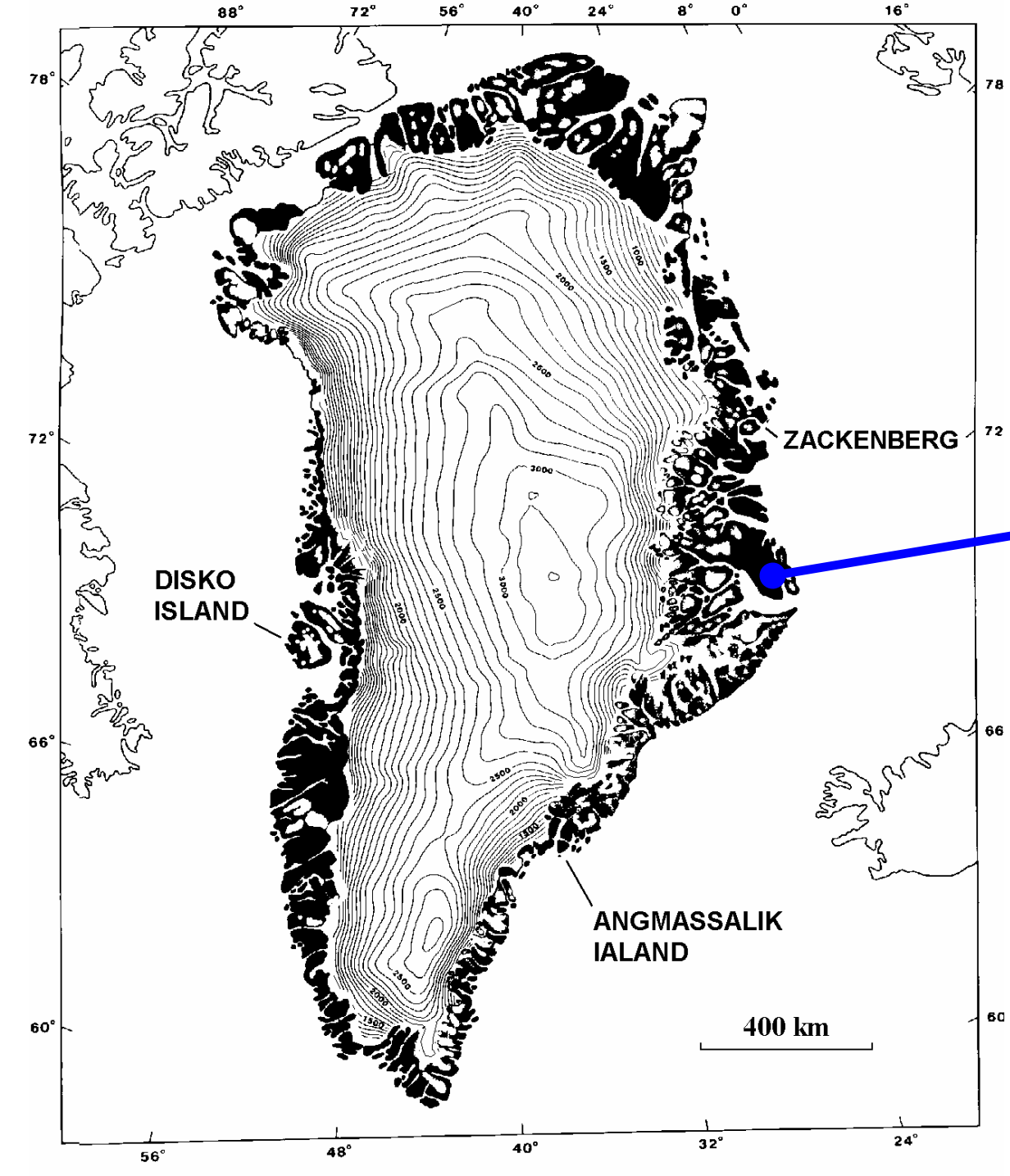
Cretaceous ↑ Tertiary

STEVENS KLINT, DENMARK


IRIDIUM ABUNDANCES
in clay residues from
pelagic limestones
age
m.y.
53.5 -
65.0 -
70.0 -
78.0
~5,000 y
~15,000 y
Tertiary
Cretaceous
log scale
linear scale
log scale
400.0 m
350.0 m
347.8 m
347.6 m
347.5 m
300.0 m
0.0 m
0 1 2 3 4 5 6 7 8
IRIDIUM IN CLAY FRACTION
(parts per billion)

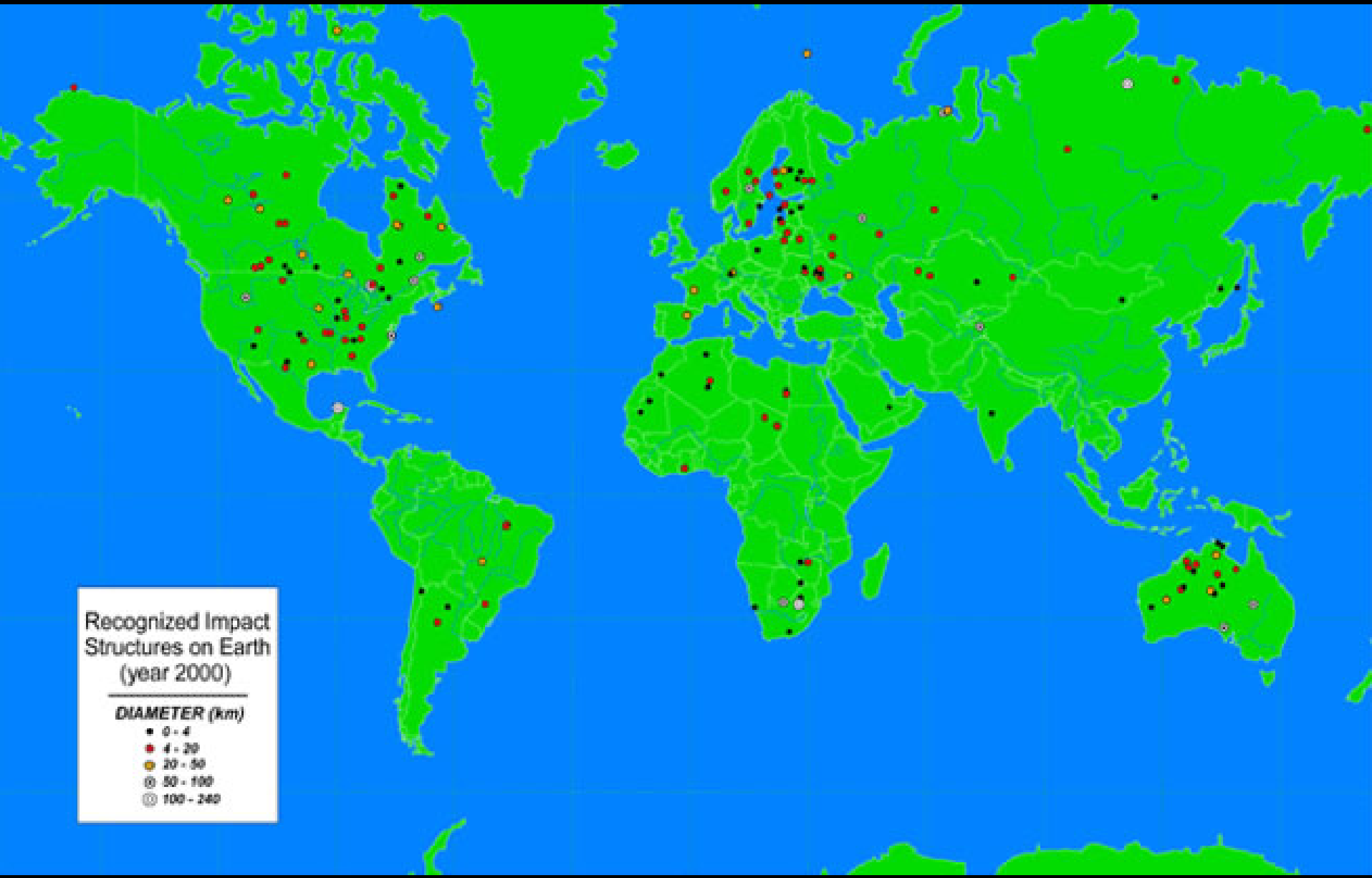

Fullerenes and Extinction Events
CAMBRIAN-ORDOVICIAN?
DEVONIAN-MISSISSIPPIAN?
PERMIAN-TRIASSIC
TRIASSIC-JURASSIC?
CRETACEOUS
506
Million Years Ago
65


Intensity of Extinction
Siberian
CAMP
Deccan
% Generic Extinction
70
60
50
40
30
20
10
0
?
C
P
Tr
J
K
T
-300
-200
-100
0
Geologic Time (my)



Kap Steward formation,
Jameson Land

Kap Steward formation, Jameson Land


Recognized Impact Structures on Earth (year 2000)
DIAMETER (km)
0 - 4
4 - 20
20 - 50
50 - 100
100 - 240

Alder (i år) eller dato	Sted	Merknad
2 milliarder	Sør-Afrika	Vredefort, det eldste kjente krateret på Jorden. Estimert diameter 140 - 300 km.
290 millioner	Canada	Clearwater Lakes, to kratere med diametre 32 og 22 km
250 millioner	Australia	Woodleigh, diameter 130 km, oppdaget april 2000. Eksplosjonen kan ha forårsaket utryddelsen på overgangen perm-trias da nesten alt livet på Jorden ble utryddet.
215 millioner	Quebec, Canada	Manicouagan, 150 km krater
200 millioner	Chad, Afrika	Kjede av flere store kratere fra en rekke nedslag. Hvert krater er større enn 10 km.
143 millioner	Australia	Gosses Bluff, 22 km krater
100 millioner	Canada	Deep Bay, 13 km krater
65 millioner	Yucatanhalvøya	Chicxulub, spor etter 170 km krater, masseutryddelse av bl.a. dinosaurene.
38 millioner	Canada	Mistastin Lake, 28 km krater
35 millioner	USA	Chesapeake Bay, 85 km krater
5 millioner	Namibia, Afrika	Roter Ramm, 3 km krater
3 millioner	Tadsjikistan	Kara-Kul, 50 km krater
2,15 millioner	SØ Stillehav	Eltanin asteroidenedslag forårsaket tsunami. Asteroide > 1 km
1 million	Ghana, Afrika	Bosumtwi, 10,5 km krater
300 000	Australia	Wolfe Creek, 0,9 km krater

65 millioner	Yucatanhalvøya	Chicxulub, spor etter 170 km krater, masseutryddelse av bl.a. dinosaurene.
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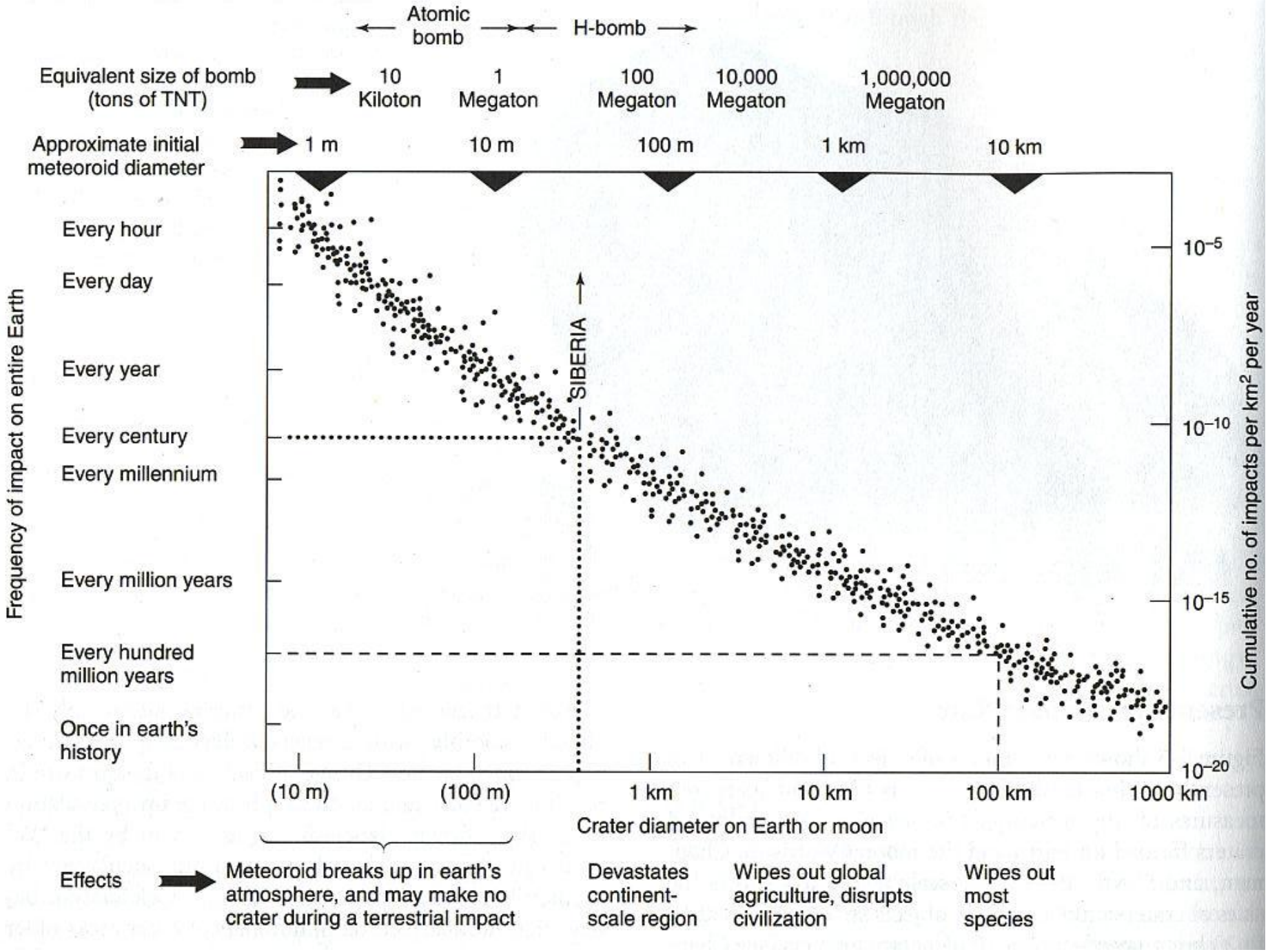
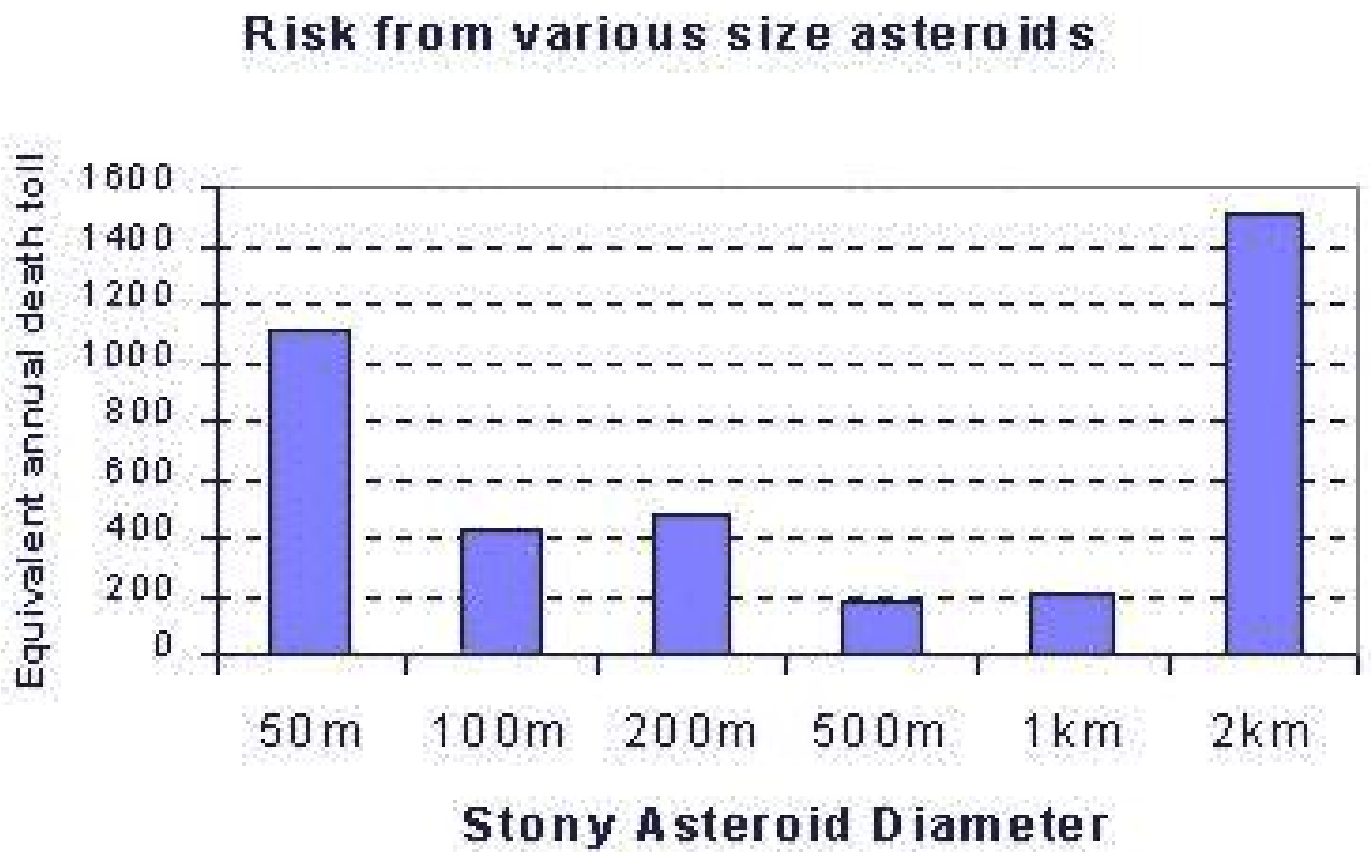
1 million	Ghana, Afrika	Bosumtwi, 10,5 km krater
300 000	Australia	Wolfe Creek, 0,9 km krater
49 000	Arizona, USA	Barringer-krateret ("Store meteorkrater"), 1,2 km diameter
120 600	Saudi-Arabia	Wabar-kraterne i Saudi-Arabia
År 1490 (ikke bekreftet)	Kina	Omtrent 10 000 mennesker rapportert omkommet
30. juni 1908	Sibir, Russland	Tunguska, trolig steinlegeme med diameter 60 meter. Legemet eksploderte ca. 8 km over bakken og flatla over 2000 km^2 skog og startet branner. 10-20 megatonn.
1930	Brasil	Tunguska-lignende eksplosjon i luften. Legemet var 10-50 meter i diameter og forårsaket betydelig skade på bakken. Ingen kratere funnet
Februar 1947	Russland	Sikhote-Alin. Ett hundre kratere over en halv meter i diameter, det største er 14 meter. Skyldtes jernlegeme som gikk i oppløsning i ca. 5 kilometers høyde.
Juli 1994	Jupiter	Fragmenter av kometen Shoemaker-Levy 9 kolliderte med Jupiter og forårsaket nedslagssoner på størrelse med Jorden.


Atomic bomb
H-bomb
Equivalent size of bomb (tons of TNT)
10 Kiloton
1 Megaton
100 Megaton
10,000 Megaton
1,000,000 Megaton
Approximate initial meteoroid diameter
1 m
10 m
100 m
1 km
10 km
Every hour
Every day
Every year
Every century
Every millennium
Every million years
Every hundred million years
Once in earth's history
Frequency of impact on entire Earth
SIBERIA
10^{-5}
10^{-10}
10^{-15}
10^{-20}
Cumulative no. of impacts per km^2 per year
(10 m)
(100 m)
1 km
10 km
100 km
1000 km
Crater diameter on Earth or moon
Effects
Meteoroid breaks up in earth's atmosphere, and may make no crater during a terrestrial impact
Devastates continent-scale region
Wipes out global agriculture, disrupts civilization
Wipes out most species



For comparison, the average annual death toll from earthquakes is about 10,000 per year. That of commercial airliner crashes is about 700 per year!

Risk of direct impact for a given location

Diameter	Kinetic Energy	Area Devastated	Average. interval (years)		
(m)	Mt TNT	sq km	Earth	"City"	Inhabited Region & Expected Death toll
50	10	1900	100 yr	30 million yr	900 yr 1 million
100	75	7200	1000 yr	70 million yr	8000 yr 3 million
200	600	29 000	5000 yr	90 million yr	30 000 yr 14 million
500	10 000	70 000	40 000 yr	290 million yr	180 000 yr 30 million
1 km	75 000	200 000	100 000 yr	260 million yr	290 000 yr 60 million
2 km	1 million MT	-	1 million yr	-	1 million yr 1.5 billion
All*			90 yr	14 million yr	800 yr

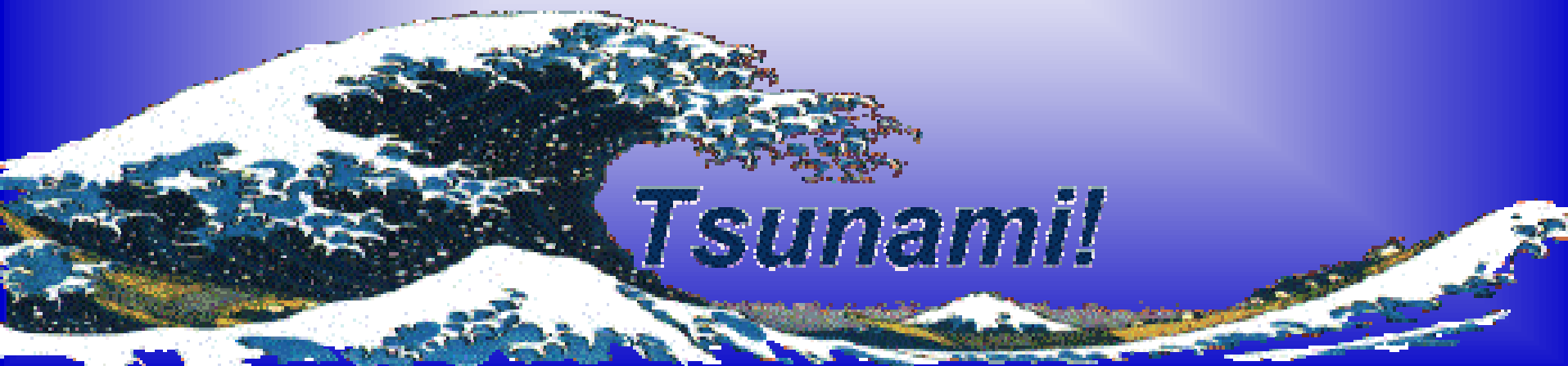
Morrison D. and Chapman C. 1995 "The Biospheric Hazard of Large Impact". *Proceedings of Planetary Defense Workshop*.

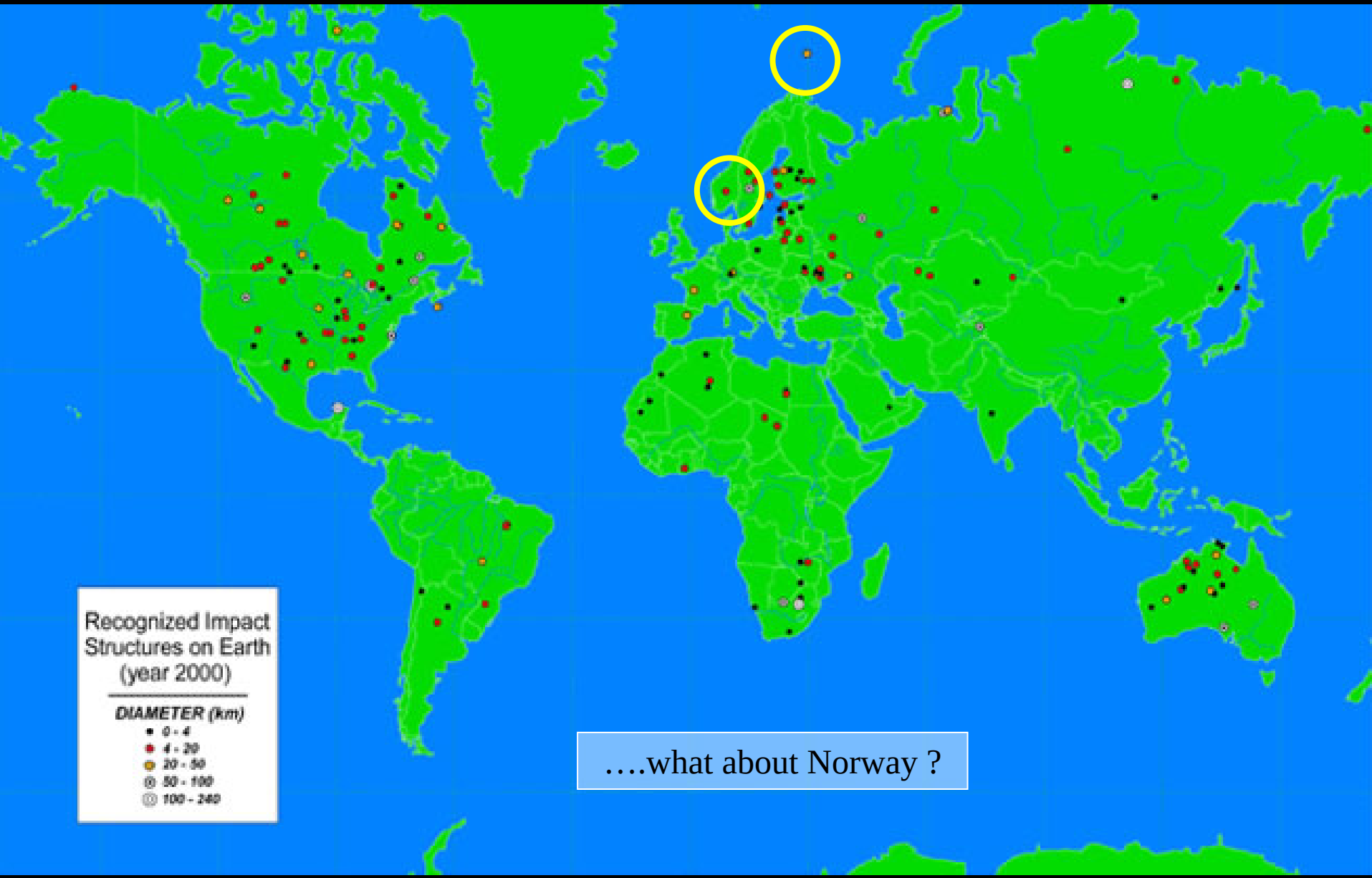
Estimate of death toll from various types of impact

Asteroid Diameter (m)	Area devastated (sq km)	"Typical" Direct Fatalities	Ratio of indirect/direct fatalities	Total fatalities	Annual chance for inhabited regions 1 in ...	Equivalent annual death toll
50	1900	200 000	4	1 million	900	1100
100	7200	650 000	4	3 million	8000	400
200	29 000	2 000 000	6	14 million	30 000	500
500	70 000	4 000 000	8	35 million	180 000	200
1 km	200 000	7 000 000	8	63 million	290 000	200
2 km	-	-	-	1.5 billion	1 million	1500
All					800	3900

71% of planet surface is water

Asteroid-generated tsunamis
may at coasts reach
height of about 200 m
- or more

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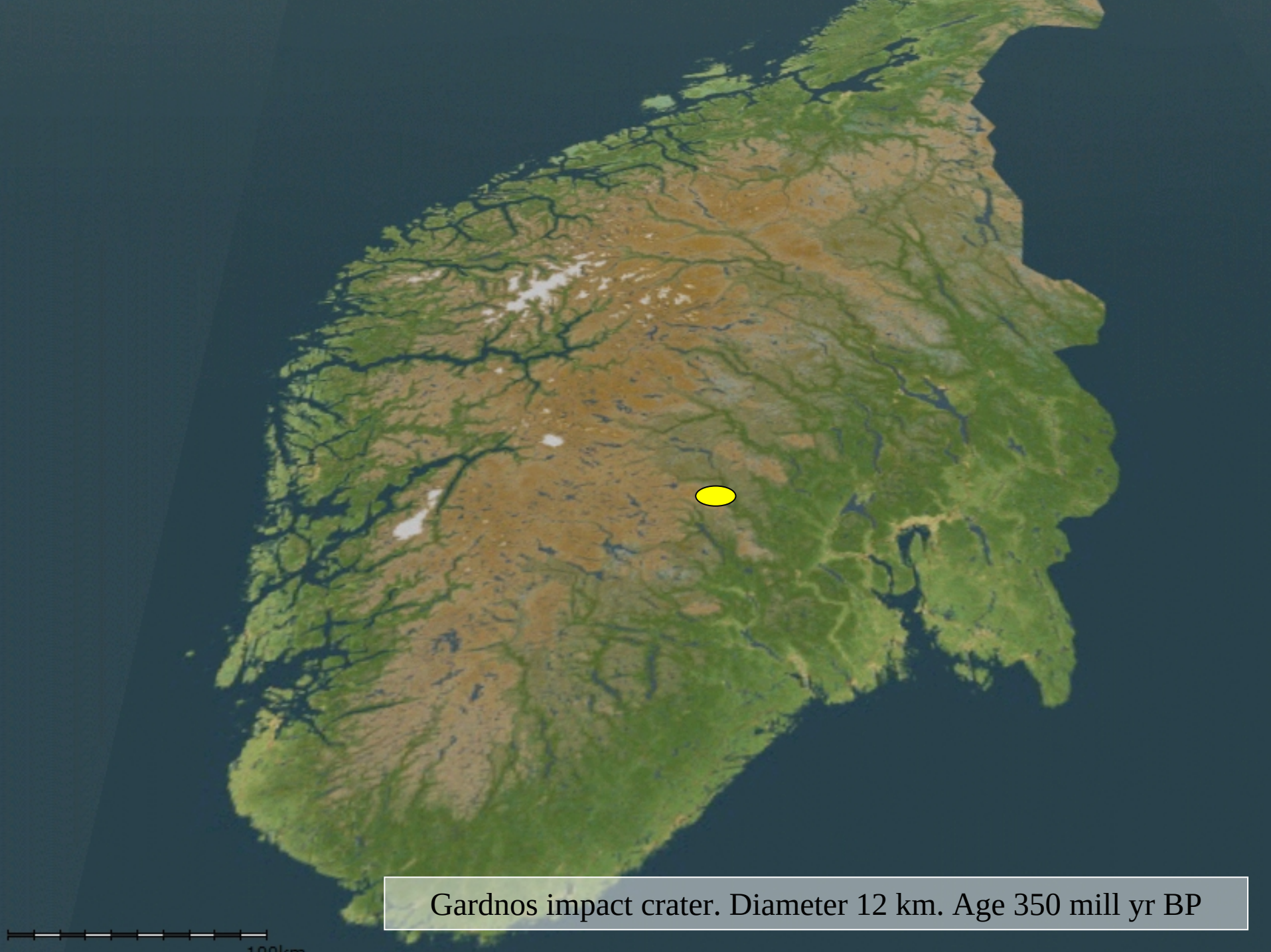
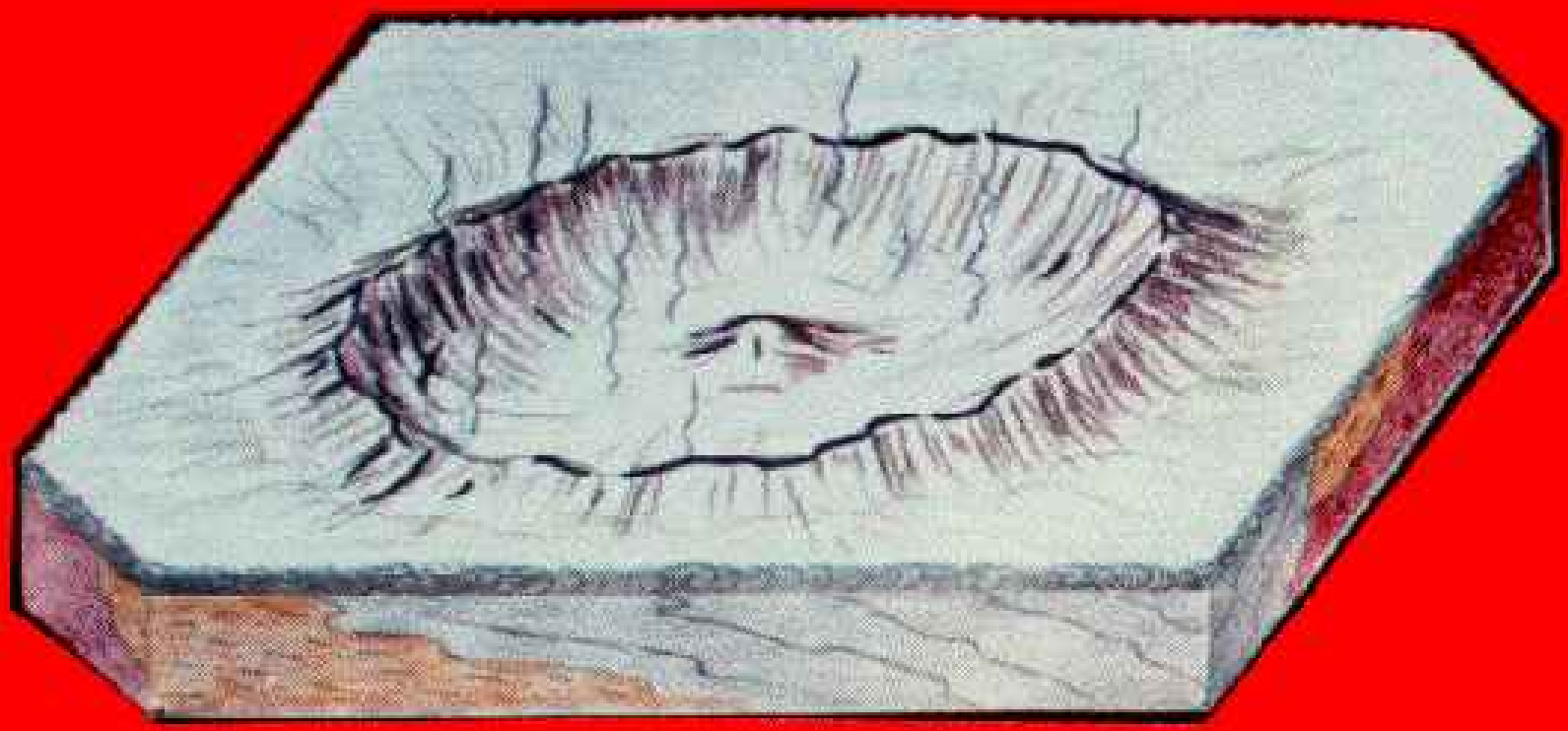
50 - 100
100 - 240
….what about Norway ?

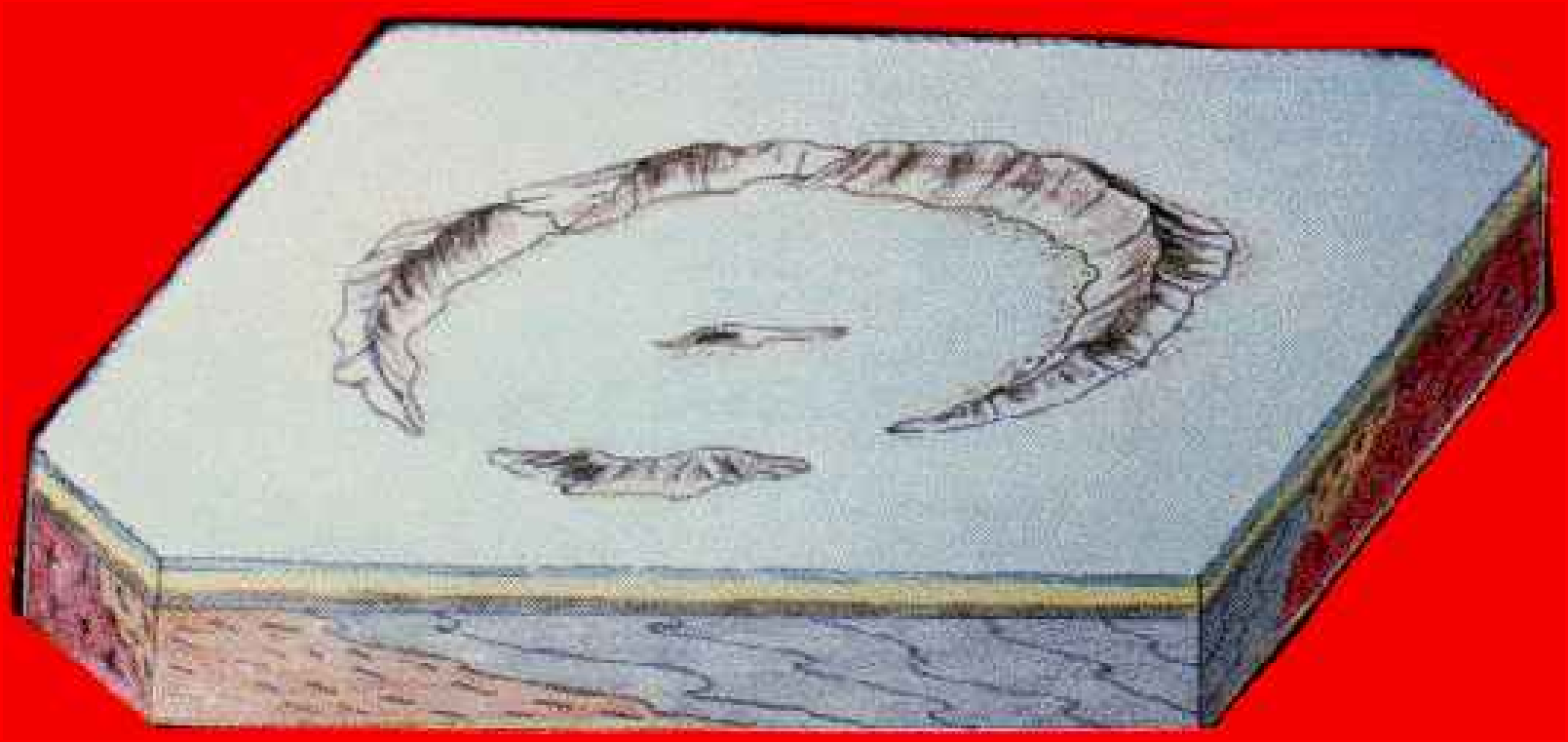

Gardnos impact crater. Diameter 12 km. Age 350 mill yr BP

Gardnos area shortly before impact

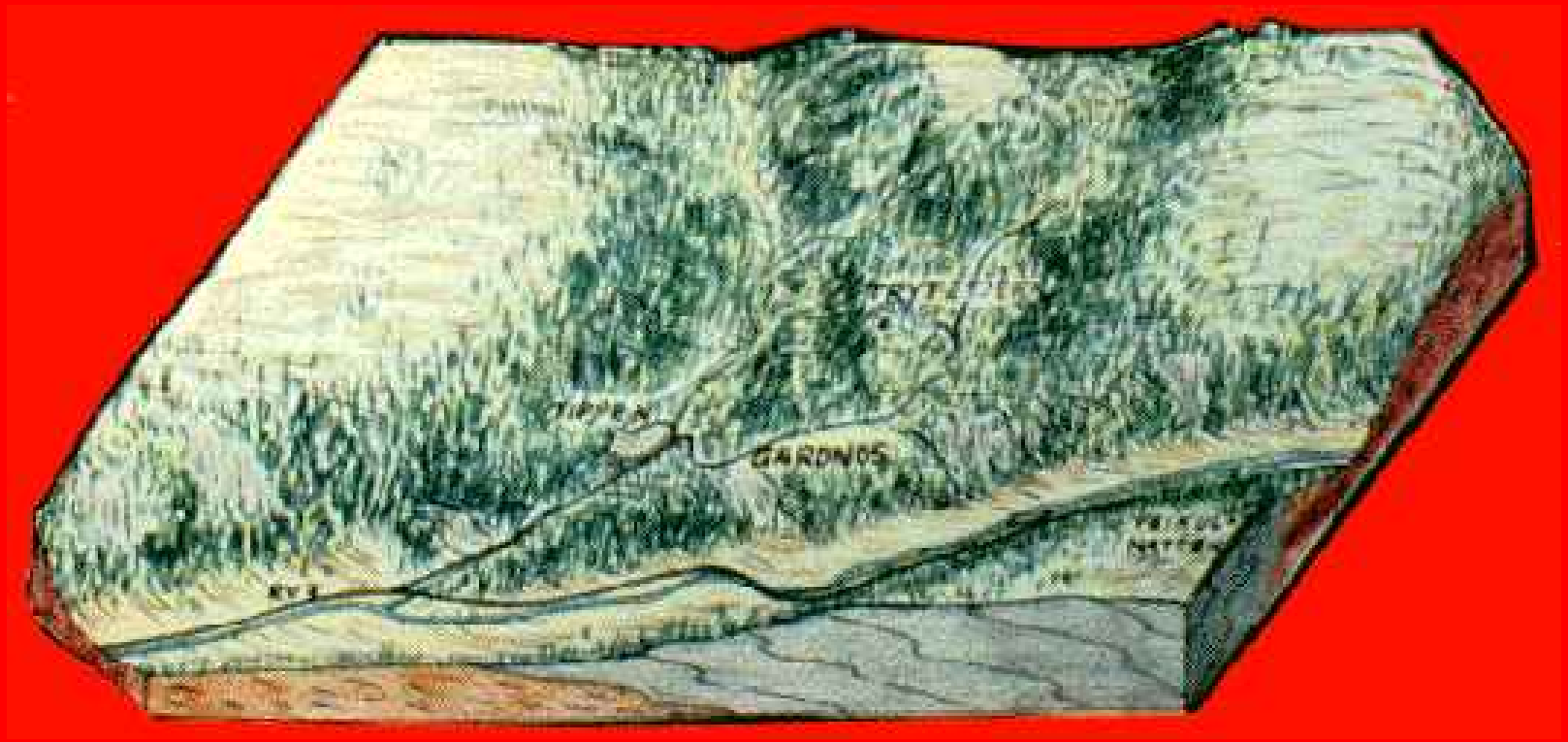
Gardnos area at impact



Gardnos area 10 minutes after impact



Gardnos area 2 years after impact



Gardnos area now

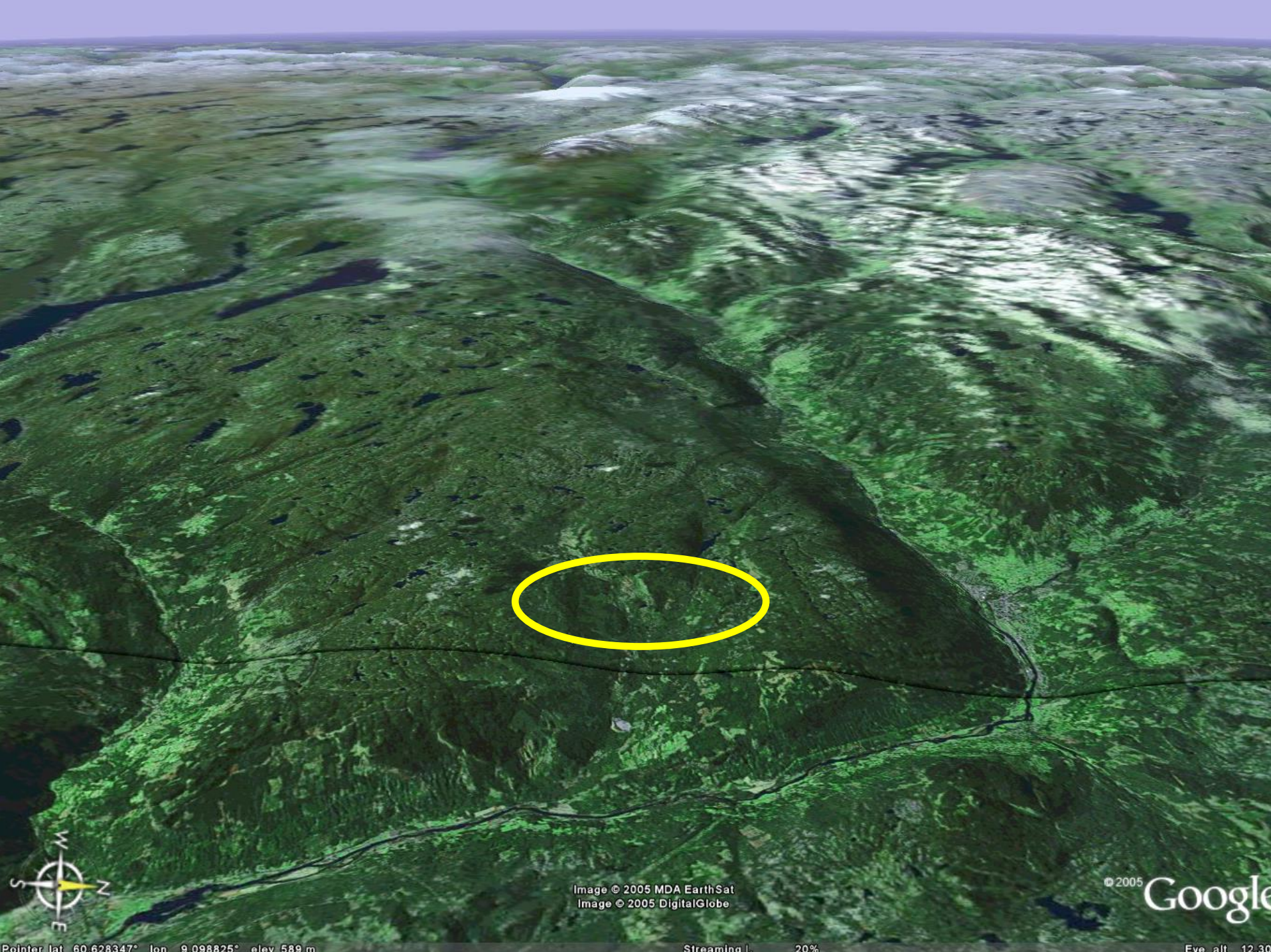
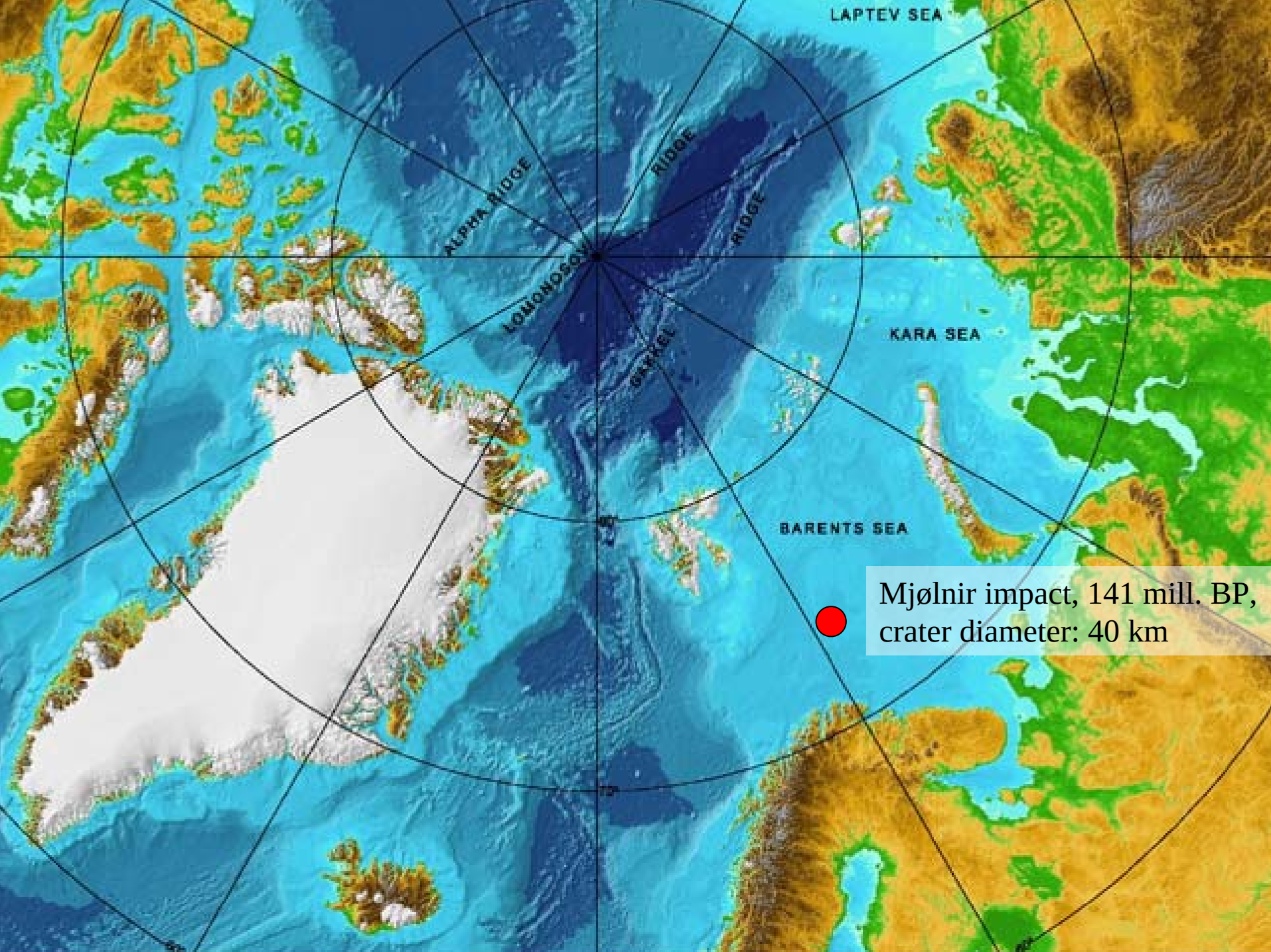


Image © 2005 MDA EarthSat
Image © 2005 DigitalGlobe
© 2005 Google
Pointer lat 60.628347° lon 9.098825° elev 589 m
Streaming
20%
Eye alt 12.30


LAPTEV SEA
ALPHA RIDGE
LOMONOSOV RIDGE
GAKKEL RIDGE
KARA SEA
BARENTS SEA
Mjølnir impact, 141 mill. BP,
crater diameter: 40 km


Meteor Crater
I-40
Little Colorado River
Winslow
[Moenkopi Fm.]
[Moenkopi Fm.: Triassic]
Meteor Crater
W. Sunset Mt.
(mesa)
E. Sunset Mt.
(mesa)
Clear Creek
N
10 km
NASA