

# **Deep Water Gulf of Mexico High Gamma Ray Shales and Their Implications for Flooding Surfaces, Source Rocks and Extinctions\***

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## **Abstract**

High gamma ray 'hot' Eocene shales were encountered in southern deepwater Gulf of Mexico wells. The two prominent shales were in the age range of 40 and 50 MYA. The shales were originally deposited in basin floor settings that palinspastically restore to water depths of greater than 20,000' sstvd. The occurrence of 'hot' shales deposited at such water depths forces the questioning of the association of 'hot' shales and maximum flooding surfaces. The influence from eustatic sea level changes in very deep water would be minimal. The deep water 'hot' shales alternatively suggest very high global temperature excursions which created extensive algal blooms and anoxic oceanic conditions. The high temperatures would cause the related cascade effects of hydrate melting, global anoxic flooding events, global alginate source rock occurrences, atmospheric compositional change, marine and terrestrial stress/extinctions and faunal lagerstatts. The age of these shales correlates with lagerstatten death assemblages in the Green River shales, the Messel fossil beds of Germany and Whale Valley in Egypt. The vertebrate death assemblages contain multiple species that died together in the same place. The articulated and unscavenged skeletal remains indicate post death predation was non existent as lethal atmospheric temperatures most likely suppressed predators and scavengers. The large number of specimens also suggests a rapid onset of thermal change. The Whale Valley lagerstatten includes a red bed containing crabs that are found in a hibernation position after mass simultaneous burrowing suggesting a rapid transition from healthy faunal community to mass death. Periods of high temperatures punctuated by brief episodes of extreme heat would explain the association of marine deep water 'hot' organic shales and terrestrial death assemblages.

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By  
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# A BLAST FURNACE EARTH? DID EXTREME HEAT CAUSE:

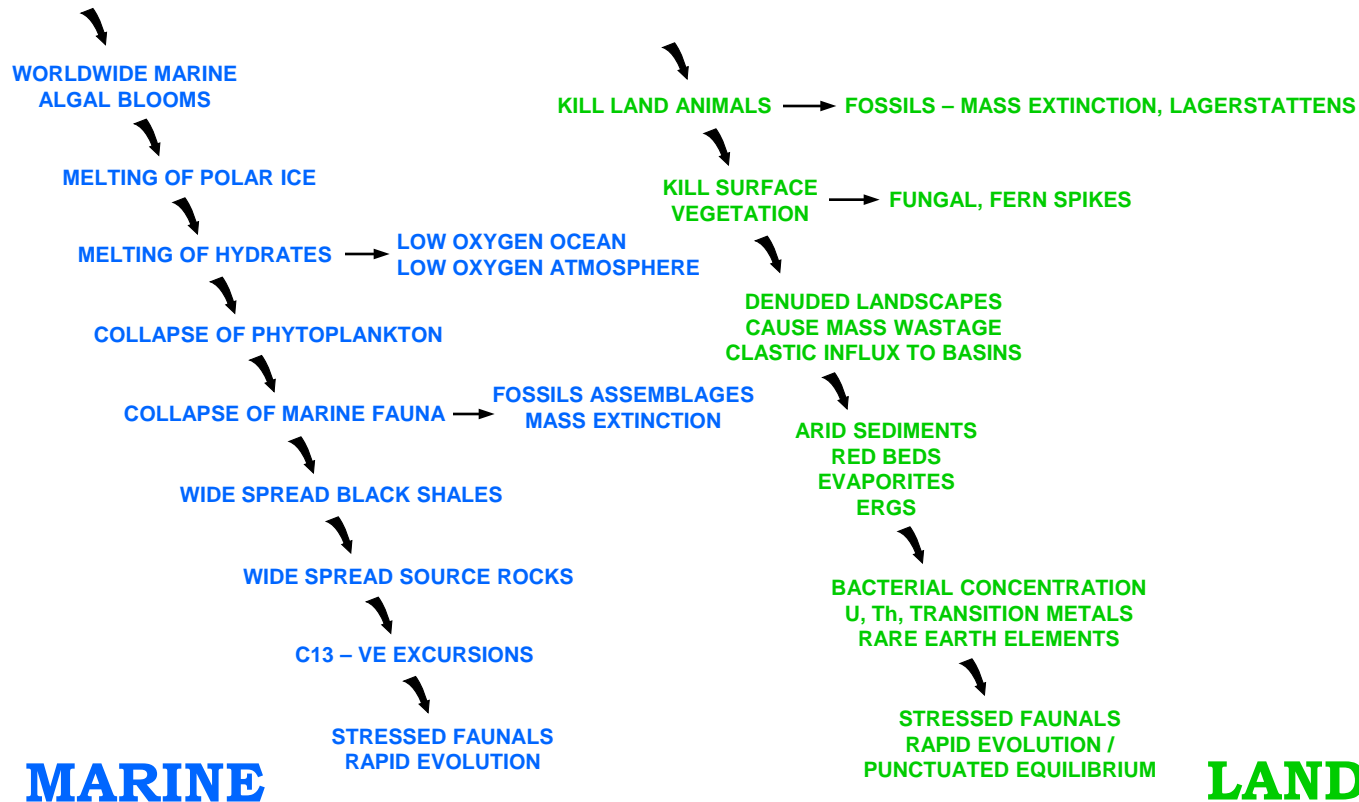
MASS EXTINCTIONS

LAGERSTATTE  
DEATH ASSEMBLAGES

GLOBAL ANOXIC  
EVENTS

SOURCE ROCKS

HIGH TEMPERATURE THERMAL EXCURSIONS



# EFFECTS OF HIGH TEMPERATURE THERMAL EXCURSIONS

ALGAL BLOOMS



- Extreme heat induces marine and lacustrine algal blooms onset of heat can be rapid and so can algal growth, 100's of thousands of phytoplankton cells/m.l. green blooms from blue green algae = cyanobacteria, life dies, bacteria grow, dissolved oxygen drops, neurotoxins can be produced, fish, plants, insects vertebrates die.
- Prolonged extreme global heat would turn oceans to an algal soup thus creating an (global) anoxic event.
- Oceans and atmosphere stop circulating and stagnate, eventually polar areas heat up.
- Black anoxic high alginate shales drop out worldwide including mid-ocean and deepwater.
- Alginate shales on oceanic crust and deepwater indicate worldwide crises, oceans affected from surface to bottom, muds not bioturbated from lack of oxygen and toxins = create massive kill of all trophic levels.
- Levels high TOC source and oil shales deposited at same time around the world.

- Polar ice melts and global flooding occurs, **eustatic sea level rise** = global anoxic events.
- Frozen marine gas **hydrates melt**, methane released to ocean and atmosphere.
- Methane and its by product **Co<sub>2</sub> increase** in atmosphere.
- Lower oxygen atmosphere creates **kill off**, allows **minerals normally oxidized to remain**.
- **High Uranium content**, Thorium, Vanadium, rare earths, Chromium, transition metals concentrated in reduced conditions.
- High rapid onset thermal spikes beyond high background temperatures.
- Lagerstatts of mixed species, **all died at same time**.
- Floras, faunas “drop in their tracks”.
- Not scavenged as scavengers killed at same time.
- Red bed and variegated shale and sand deposition.

- Rapid kill off of vegetation, **fungal and fern dominance**, (palynology spike) **arid sediment deposition** – Aeolian sands, ergs, evaporites, red beds vegetation killed, terrestrial sediments lose binding and cause en-masse slumping.
- **Mass wastage slumps** and deposits, clastic influx to basins.
- Phosphatic deposits.
- Stressed faunas, rapid evolution of survivors to adapt.
- C 13 – ve excursions indicates high temperatures
- Source – rocks/black shales deposited at same time around the world.
- Polar areas cooled last, **extinctions later at poles** indicating extinctions thermal in causation.
- Species “sickly” after extinction if survived.
- Coal gaps, no plants for herbivores.

# COMPETING CAUSES

- Bolide Impacts – no impact evidences, why would they cause flooding & anoxia, impact would have cooling winter effect. Volcanism, slow back ground process, continuous throughout geologic history, does not match all events.
- $\text{CO}_2$  increases insufficient to cause rapid mass extinction criteria.
- Pangaea continental configurations – thermal events occurring throughout Phanerozoic despite many plate configurations/supernova – not aligned with timing of thermal crises.
- What else can **kill on land and sea at same time** and deposit petroliferous shales from algal source?
- No need for exotic events but still needs source of extreme heat.
- Cooling events, glaciation & isotopic signatures missing from thermal crises.
- **Extreme heat** is only mechanism to explain terrestrial and marine crises, flooding / sea level rise, worldwide anoxic events, thick petroliferous shales, faunal and floral lagerstatts with no scavenging, geochemical signatures and concentrations of metals.



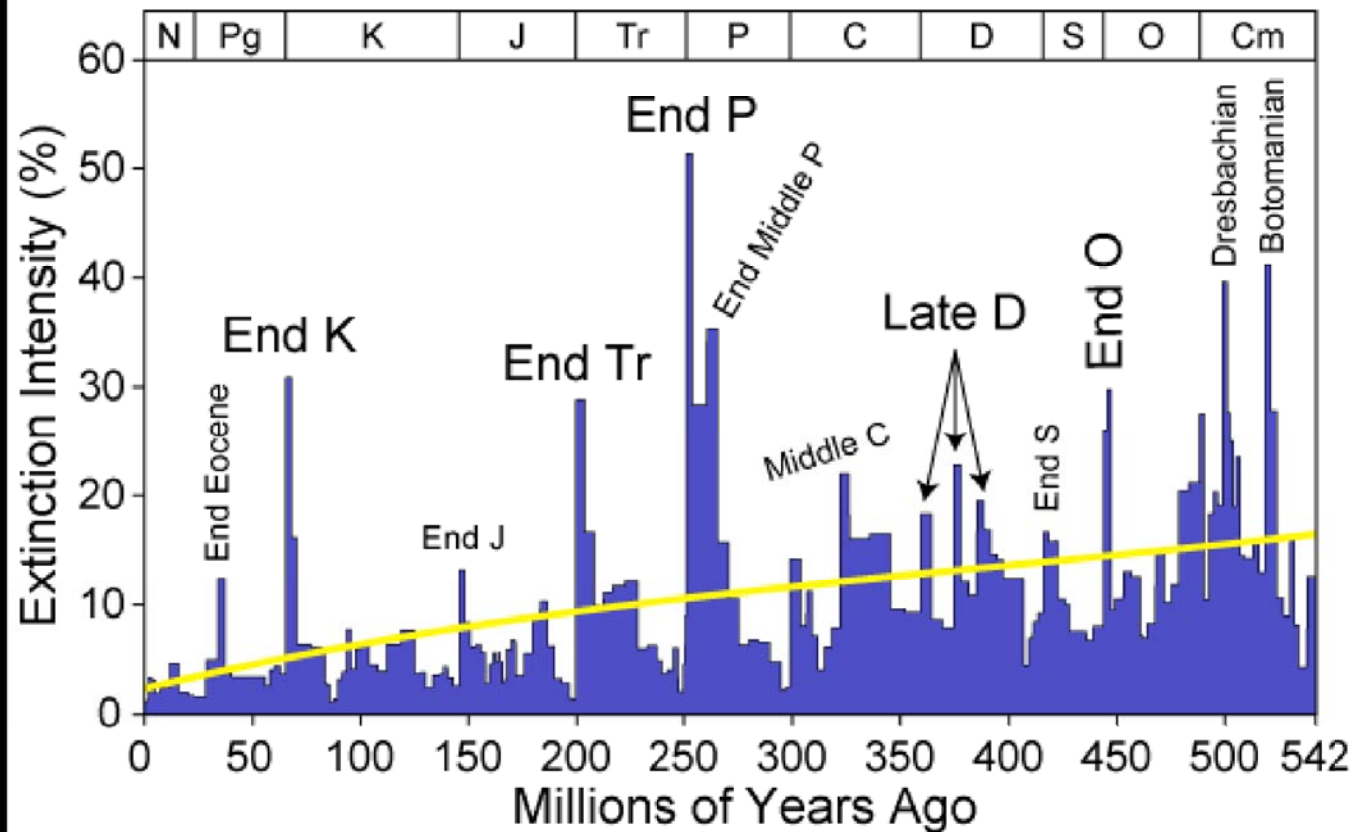
# **FLOODING SURFACES IMPLICATIONS**

**Assumes hotter black shales are deposited at base of deepest water**

**But: If hot shales usually correlated as deep water indicators are only responses to heat and alga buildup then water depth implications don't apply**

**Correlating on gamma spikes as maximum flooding surfaces would be wrong**

## Marine Genus Biodiversity: Extinction Intensity



# CASE HISTORIES OF EXTREME HEAT INDUCED CATASTROPHES

## Permian Extinction

**251 MYA – THE GREAT DYING, 96% species extinct**, arid sediments in late Permian, terrestrial vertebrates “ died in their tracks “, no scavenging, terrestrial floras killed off, fungal spike, polar region had extinction after tropics C13 – ve spike, denuded landscapes, En-masse slump deposition from lack of vegetation; 97% forams, 100% fusulinids, 99% radiolarids, tabulate rugose corals, 100% fenestral bryozoans, 79% bryozoans, 98% brachiopods, 50% bivalves, 98% gastropods, 97% ammonites, 98% crinoids, 100% blastoids, 100% trilobites, 100% eurypterids, 100% graptolites, 100% acanthodians, 100% placoderms, 2/3 sauropsid reptiles and therapsid mammal – like reptile families, 100% anapsid reptiles, insects, Paleozoic plants suffered heavy losses; stromatolites microbes re-emerge UV radiation damage to spores, fossil biomarkers of green sulfur algae; arid conditions existed into Triassic, phosphoria deposits, U, metals concentrated.

## Ordovician Extinction

**~ 443 MYA**; brachiopods, trilobites conodonts, **60% of marine genera**, glaciation or anoxia? Michigan basin shows distinct thick black alginite Shales, red beds, post thermal clastic influx, stromatolites, microbes reemerge = low O atmosphere, lack of grazers and scavengers, Glaciation in polar areas, 2 periods of low sea level.

## Silurian Lau Event

**416 MYA**; 3 events ~ 420 MYA, **Lau, Sweden**, worldwide crisis conodonts, graptolites, microbial colonies re-emerge -ve C13 = arid conditions, fungi englenids, euglene green algae = algal bloom stromatolites = low oxygen atmosphere, lack of grazers and scavengers flat pebbles conglomerates, ferruginous infill in Eke/Bungsvik in Sweden. Poor lateral correlations, clumping ? Flooding & sea level rise.

# CASE HISTORIES OF EXTREME HEAT INDUCED CATASTROPHES

## Cambrian and Cambro-Ordovician

**488 MYA** Cambrian experienced numerous anoxic events

500 to 525 MYA = point of Cambrian fossil explosion, Burgess shales archeocyathid biota frozen in their tracks in Labrador.

## Upper Devonian Frasnian Fammenian

**360-364 MYA** – Extensive anoxic black shale deposition plus oil shales Kettle Point, Woodford, Chattanooga, tasmanites algal domination=bloom, old red sandstone and sediments most skeletal reef building fauna eliminated, fossil agnathin fish in crisis, **345-365** evolution of lobe fin fish to handle arid conditions, stromatoporoids, rugose, tabulate corals, **22% of marine families, 57% genera, 75% species**, crisis for brachiopods, trilobites, ammonites, conodonts, acritarchs, placoderms.

## Triassic Jurassic

**200 MYA 20% all marine families**, non dinosaur archosaurs, large amphibian in crisis/gone 50% of species gone Triassic very arid, worldwide red beds, Triassic – Jurassic sand seas (ergs) extension arid sediments, decline of equator to polar temperature differentiation and loss of oceanic circulation.

## Jurassic

Jurassic better preserved global anoxic events **70% of source rocks in Mesozoic 15% in Paleogene Thermal Maxima.**

# CASE HISTORIES OF EXTREME HEAT INDUCED CATASTROPHES

## Toarcian Global Anoxic Event

Jurassic 183 MYA Toarcian Ghost Ranch N.M., Cook Inlet source, France  
no oceanic samples but wide spread on land, 188 MYA Ichthyosaurus lagerstätten N. Yorkshire  
190-195 MYA Marine Reptile Lagerstätten – Jurassic Coast UK

## Upper Jurassic Morrison End Jurassic Extinction

155-145 MYA – Dinosaur lagerstätten variegated shales, arid sediments, Kimmeridge source  
rocks 147 Cleveland Lloyd allosaurus lagerstätten Utah, Smackover evaporites, Arab  
evaporites Brushy Basin Uranium

## Cretaceous

Pacific ocean deepsea drilling on oceanic crust found black shales = age of Europe & Atlantic  
ocean cores laminations undisturbed, green sulfur biomarkers

## Aptian/Anoxic Event

120 MYA (Selli Event) Oella base fish scales, western interior, Viking/dakota clastic influx,  
feathered dinosaur lagerstätten Crato Brazil albian glauconite? Thick African Nubian clastic  
influx, Burgan of Kuwait

## Cenomanian/Anoxic Event Turonian Highest Sea Level

93 MYA (Bornelli Event) OAE2 – Turonian crisis, Colorado shale 'hot' response, cardium/  
Frontier clastic influx  
Niobrara, white specks  
Late Cretaceous coccolith chalks = modern Bering sea coccolith blooms.  
L.K. Mongolia oil shales flaming cliffs arid sediments dinosaur lagerstätten "frozen in tracks"  
Deepwater black shales, green river, Messel pits, Whale Valley lagerstätten, London clay

## Cretaceous Iron Rich Sediments

Warm – chalks, dinosaur lagerstätten, episodes of heat  
Glauconite Fm, Neocomian – Santonian Nezzazat Fm. Of Egypt

# **SUMMARY**

## **CHECK LIST FOR EVIDENCE OF HIGH THERMAL EXCURSIONS**

BLACK SHALES – ‘HOT’ – ALGINATE ORGANIC RICH, OIL PRONE SHALES, SOURCE ROCKS, ALGAL BLOOMS GIVE HIGH TOC

ALGAL PALYNOFORMS – TASMANITES, EUGLENA

FLOODING HIGH STAND

ANOXIC EVIDENCE – WIDE SPREAD WORLDWIDE

SPECIES EXTINCTION, LAND AND MARINE

MASS DEATH LAGERSTATTEN

C13 SHIFTS WARM ISOTOPE SIGNATURES

STRESSED SPECIES, RAPID ADAPTIVE EVOLUTION

FOSSILS ‘ DROPPED IN THEIR TRACKS ‘

ARID SEDIMENTS, DUNES, ERGS

RED BEDS, CALICHES

EVAPORITES, SELENITES, SALT

MASS WASTAGE, ENMASSE SLUMPS

CLASTIC INFUXES

PHOSPHATES

CHALK, COCCOLITH BLOOMS

STROMATOLITES ALGAL ENCRUSTMENTS

FERN SPIKES

FUNGAL SPIKES, DEAD VEGETATION, COAL GAP

NON DEPOSITION EVENTS

DEEPWATER, OPEN OCEAN BLACK SHALES

POLES COOL LATER THAN EQUATOR

POLAR EXTINCTIONS LATER THAN TROPICS

U, Th, RARE EARTH ELEMENTS, TRANSITION METALS, VANADIUM

CHROMIUM

ALGAL BIO MARKERS, GREEN SULFUR

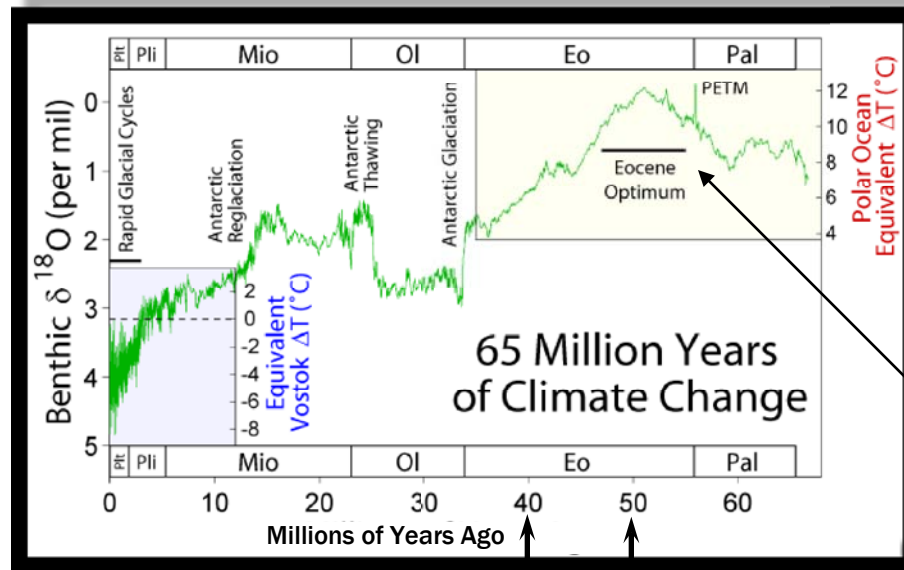
EVIDENCE OF LOW OXYGEN ATMOSPHERE, REDUCTION SURFACES, PYRITE STRESSED SPORES, POLLENS, ARID VEGETATION

HEAT ADAPTATION, LOBE FIN FISH DEVONIAN LEGGED FISH

SINGLE AND MULTIPLE HEAT WAVES, LONG DURATION HEAT WAVES

GLAUCONITE, IRON RICH SEDIMENTS

**PETM: PALEOCENE/EOCENE  
THERMAL MAXIMUM**



Deepwater  
Hot Shales

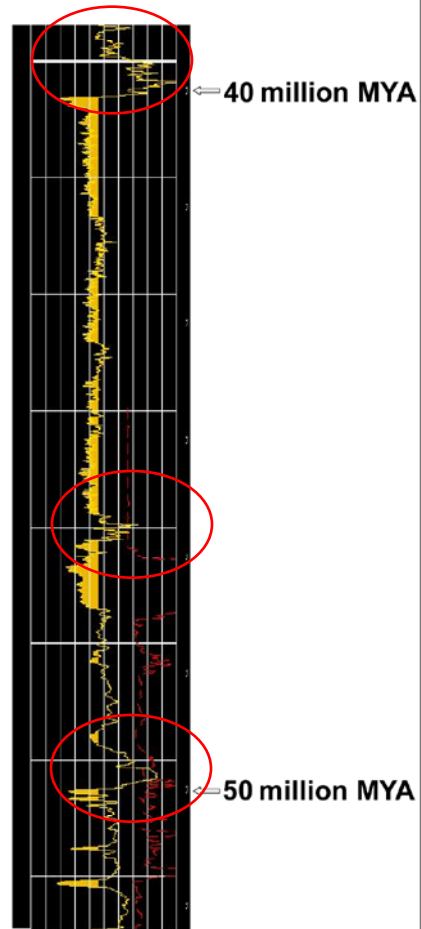
## PETM CHARACTERISTICS

Sea surface temperature rose 5-8°C in a few thousand years, oceanic & atmospheric circulation changed, arctic sea surface to 25°C, subtropical algae extinction of deep sea benthic foraminifera, terrestrial mammalian species turnover, stressed fauna created modern mammals, **entire depth of ocean warmed**, oxygen content depleted, oceanic basins filled with dense, warm, salty water C13 dominated atmosphere = Hydrate melting? Methane & Oxygen = CO<sub>2</sub> 2,000 to 3,000ppm CO<sub>2</sub> VS 380 currently.



## DEEP WATER GULF OF MEXICO LOGS

Deep water  
shales  
unaffected  
by eustatic  
sea level  
reflect entire  
depth of  
oceanic  
conditions

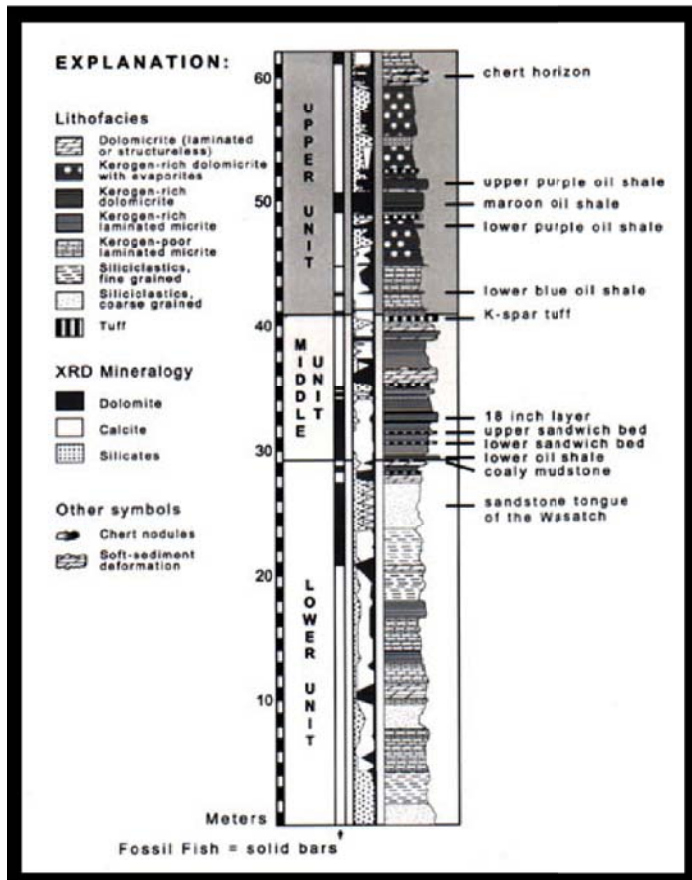


**EFFECTS OF THIS HIGH THERMAL EXCURSIONS HAVE  
BEEN WELL DOCUMENTED BY FOSSIL LOCALITIES**

**“ ANIMALS DROPPED IN THEIR TRACKS”**

# GREEN RIVER FOSSILS & SOURCE ROCKS/OIL SHALE

48-50 MYA



*Knightia eocaena* are sometimes found in mass death layers.

**MESSEL PIT 50 MYA**



**MULTI SPECIES PLANTS,  
VERTEBRATES BEDS UNSCAVENGED**



## WHALE VALLEY EGYPT 40 MYA



Archaeoceti whales *basilosaurus isis*, crabs *Lobocarcinus aegypticus*  
lagerstatte hundreds of whales died en-masse thousands of crabs  
buried themselves under what became a red bed, were they driven  
by extreme heat to cooler depths but the temperature never cooled  
until after red bed deposition?

Whales unscavenged after “beaching” driven out of toxic waters  
So hot even scavengers had succumbed.

# UPPER JURASSIC MORRISON MULTI SPECIES LAGERSTATTE



## **OTHER HEAT INDUCED DEATH ASSEMBLAGES?**

**JURASSIC MORRISON, BRUSHY BASIN MEMBER UTAH, ROCKIES 150 MYA SELENITE,  
U SOLNHOFEN LIMESTONE GERMANY 145 MYA  
HOLZMADEN GERMANY MARINE VERTEBRATES, SKIN INTACT 160 MYA  
EOCENE MONTE BOLCA ITALY 50 MYA, HIGH PRESERVATION,  
LONDON CLAY 54-48 MYA PYRITE, SELENITE, BIRDS, PLANTS, MAMMALS, FISH,  
INVERTEBRATES  
CRETACEOUS SANTANA BRAZIL 108-92 MYA FISH, DINOSAURS, PLANTS, AMPHIBIANS,  
REPTILES, INSECTS also in SANTANA CRATO MEMBER 117 MYA  
YIXIAN CHINA 135 MYA DINOSAURS PLANTS BIRDS, MAMMALS, REPTILES  
SILURIAN WENLOCK ENGLAND 420 MYA LAU EXTINCTION EVENT DELICATE WORMS  
SPONGES, GRAPTOLITES  
RHYNIE CHERT UK 400 MYA DEVONIAN PLANTS ARTHROPODS, PSEUDO SCORPIONS,  
ARACHNIDS  
40 CAMBRIAN LAGERSTATTENS, WORLDWIDE, eg. CAMBRIAN ALUM SHALE  
SWEDEN 500 MYA HI U, MUD BOTTOM,  
BURGESS SHALE CANADA 505 MYA BLACK FINE GRAINED SHALE  
NO SCAVEGING; LABBRADOR CANADA L./ CAMBRIAN FORTEAU  
ARCHAECYATHID REEFS FAUNA "FROZEN IN PLACE"**