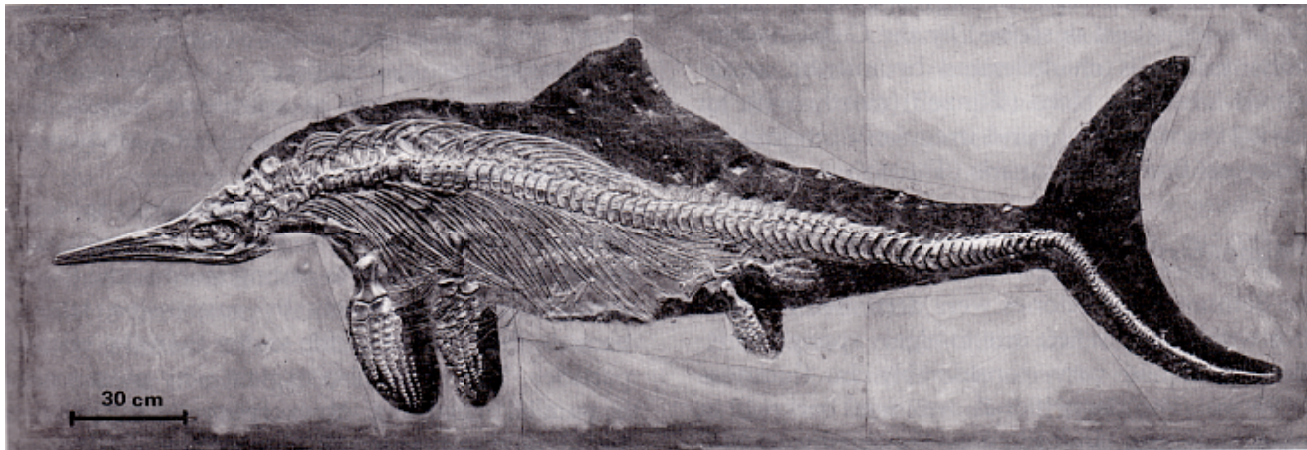
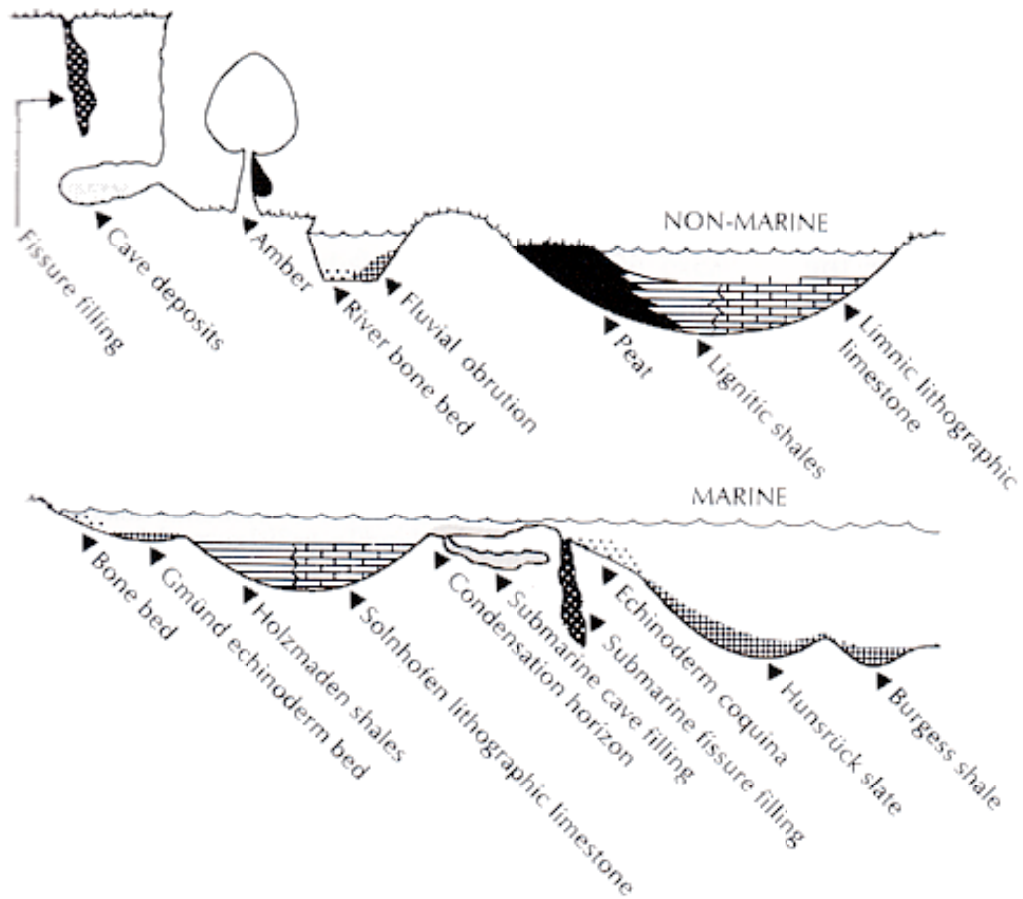


Fossil Lagerstätten: Unusual Preservation of Fossils



Concentration vs Conservation Deposits



CONCENTRATION DEPOSITS	
Condensation deposits	
Placer deposits	
Concentration traps	
CONSERVATION DEPOSITS	
Stagnation deposits	
Obrution deposits	
Conservation traps	

Concentration Deposits

- Anomalously large amounts of fossil material
- Possibly by decreased rate of sedimentation
- Possibly by increased rate of organism reproduction ("bloom")
- Possibly by increased rate of organismal death

Concentration Deposits

- Condensation deposits (decreased rate of sedimentation)
- Placer deposits (hydrodynamic concentration by currents, eddies)
- Concentration traps (holes, pits, caves)
- Examples
 - Coquinas
 - Oyster beds
 - Bone beds

Conservation Deposits

- Unusually well preserved fossils
- Conservation Traps
 - Stratiform Conservation Deposits
- Ostracite Deposits - famous example?
- Stagnation Deposits - anoxia

Conservation Deposits

Obrution Deposits

Obrution - the rapid burial of living organisms on the seafloor. This entombs organisms quickly preventing the working of biostratigraphic processes such as disarticulation, abrasion and bioerosion.

Obrution deposits are usually the result of storm or debris flows that cause large amounts of sediment to flow rapidly over the seafloor, smothering and burying the organisms present.

Conservation Deposits

Stagnation Deposits

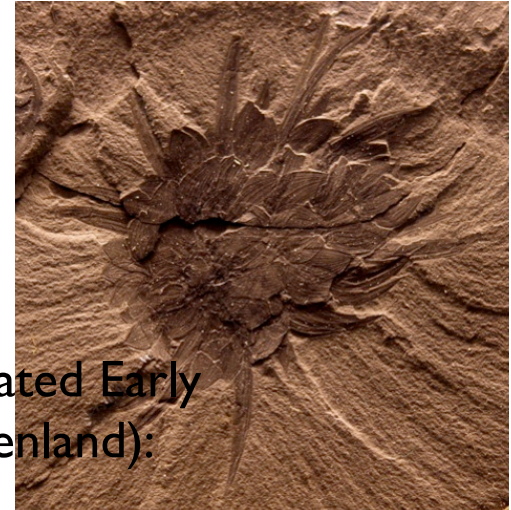
Stagnation - the inhibition of decay due to low oxygen levels or high salinity levels. Stagnation often results in a variety of unusual chemical environments that promote the preservation of soft tissue, both by slowing its destruction as well as by encouraging mineralization.

Soft Tissue Preservation

- ✓ Typically bacterially mediated
- ✓ Generally begins VERY quickly (diagenesis starts within hours of burial)
- ✓ Rate of burial, salinity, and organic content of sediment and organisms will determine which new (authigenetic) minerals form to preserve soft tissue:
 - ❖ These include pyrite, carbonates (calcite and siderite), phosphates and silica
 - ❖ *Pyrite*: rapid burial, low organic content, normal or near-normal salinity, and sulphate must be available
 - ❖ *Carbonates*: rapid burial, high organic content. For low salinity, siderite forms; normal salinity favors calcite
 - ❖ *Phosphates*: low rate of burial, high organic content. For low salinity, vivianite; normal salinity, apatite
- ✓ Three common modes of soft tissue preservation by authigenic minerals:
 - ❖ *Permineralization*: rare, and only phosphates. Most effective of "hard" soft tissues, like cellulose and chitin
 - ❖ *Mineral coats*: most common. May be phosphate, carbonate or pyrite.
 - ❖ *Tissue casts*: rapid stabilization of sediments through diagenesis prior to lithification of rock as a whole. Often as nodules and concretions. May be siliceous or calcareous.

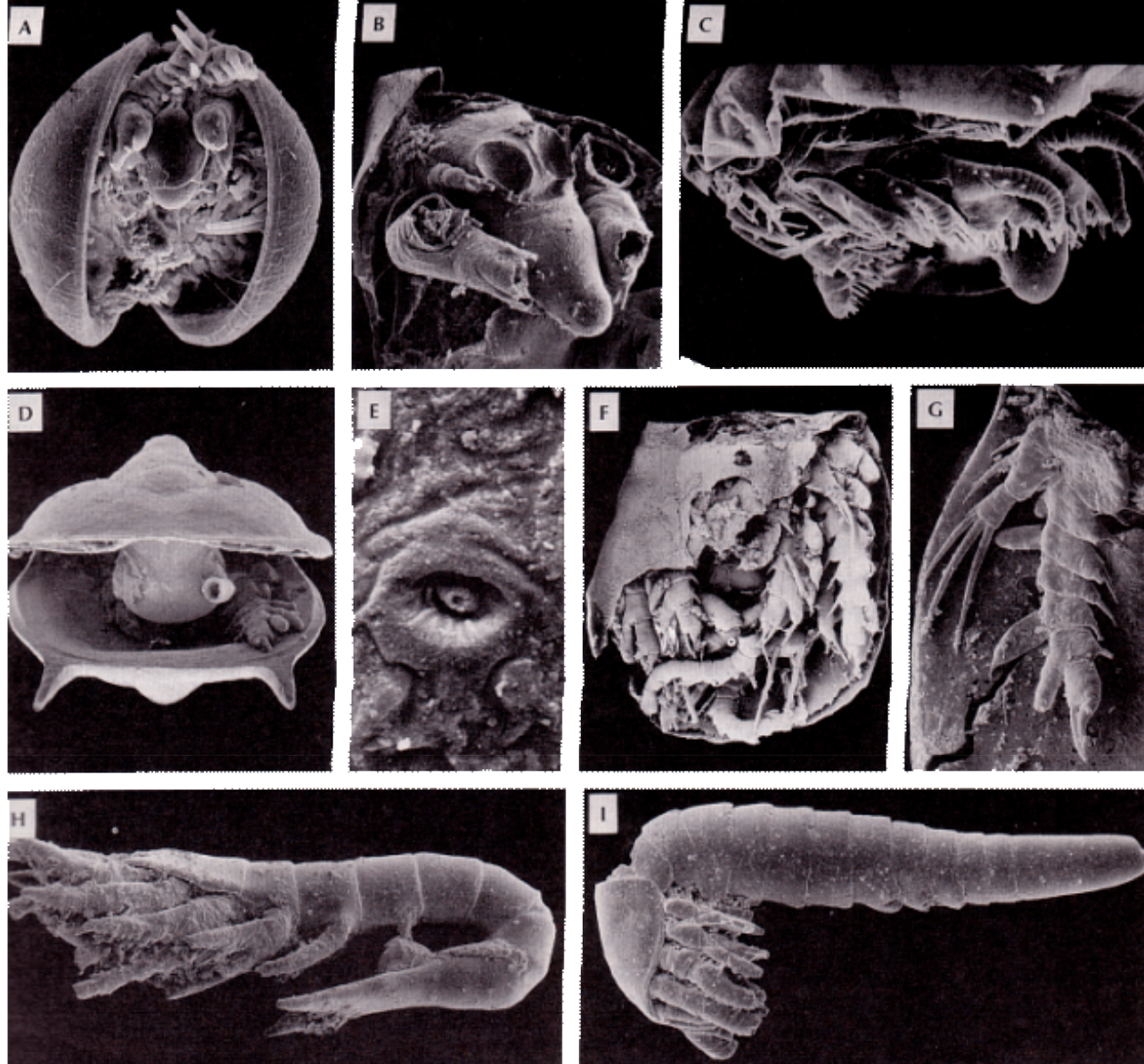
Case Histories

Burgess Shale



- (Middle Cambrian, British Columbia, Canada) and related Early Cambrian sites (Chengjiang, China; Sirius Passet, Greenland):
- Environment: obrution deposits from limestone escarpment into deeper water by turbidity current
- Preservation: carbonization enhanced by pyrite (some films are actually calcium aluminosilicates!), preserving soft tissue of many taxa
- Significance: demonstrates high taxonomic diversity and morphological disparity of Cambrian forms which would not have otherwise been preserved. Did not probably represent an unusually diverse community compared to other Cambrian sites: instead, shows us what "typical" Cambrian faunas actually were like (i.e., they weren't all trilobites!!)

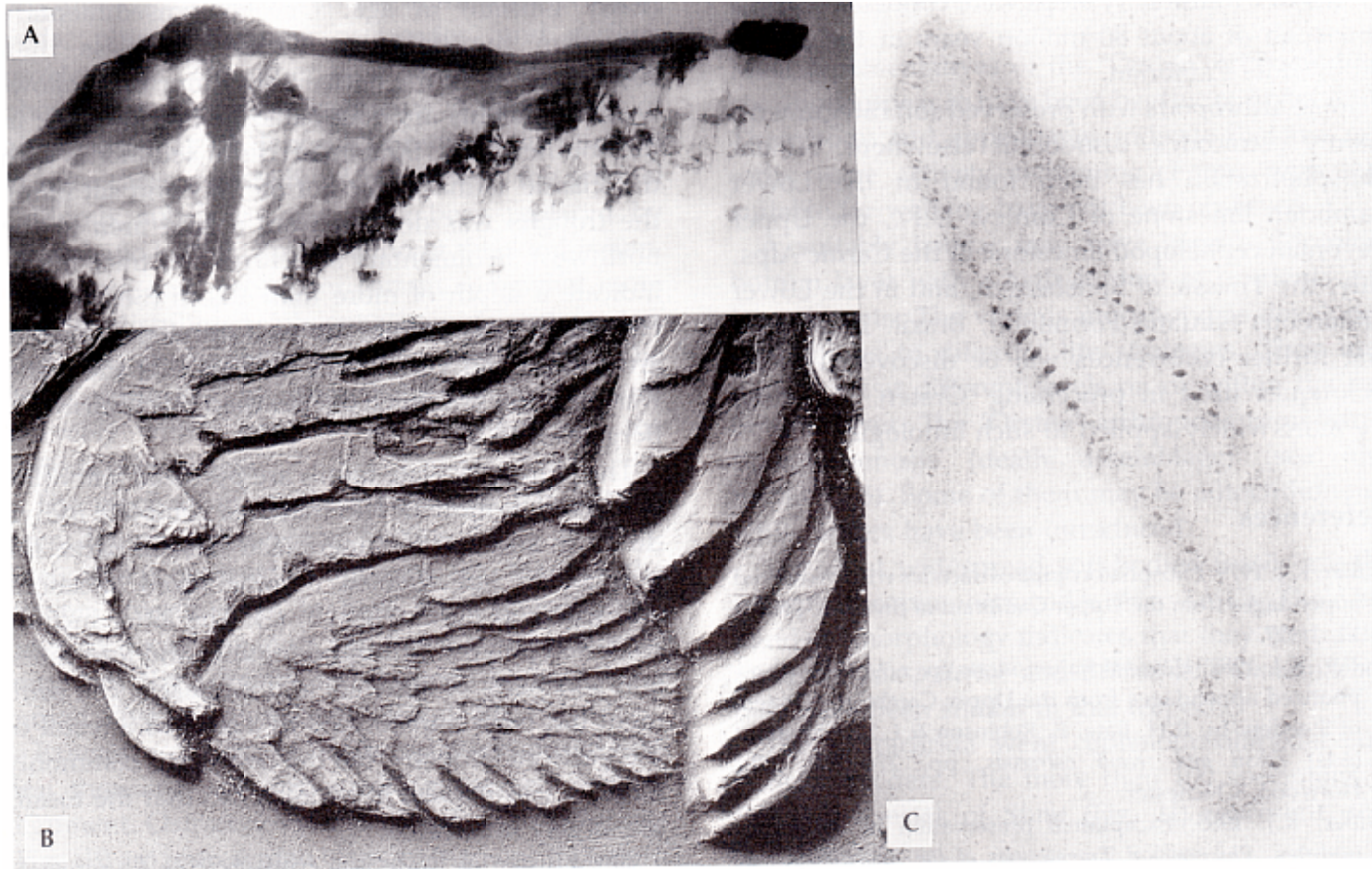
'Orsten' U. Camb. Alum Shale



Orsten is a sulfurous anthraconitic limestone occurring as pods in the Alum Shale. The pods are also petroliferous and when dissolved oil usually floats to the top. Though not common, it is the phosphatic fossils that are well preserved and unusual in their level of 3D detail that is preserved.

Preservation is by phosphatisation of the chitinous body wall.

Hunsrück Slate



The fossils are pyritized and are often preserved as flattened complete individuals. The pyritization affected unmineralized skeletons and true soft parts (B & C above). These include Cnidarian polyps, arthropod muscles and intestines and soft parts of annelids and mollusks. Most best seen with X-rays.

Obrution Deposit. Preservation by early pyritization - best developed where there was much organically bound sulfur. Postmortem production of H_2S was important for rapid pyritization.

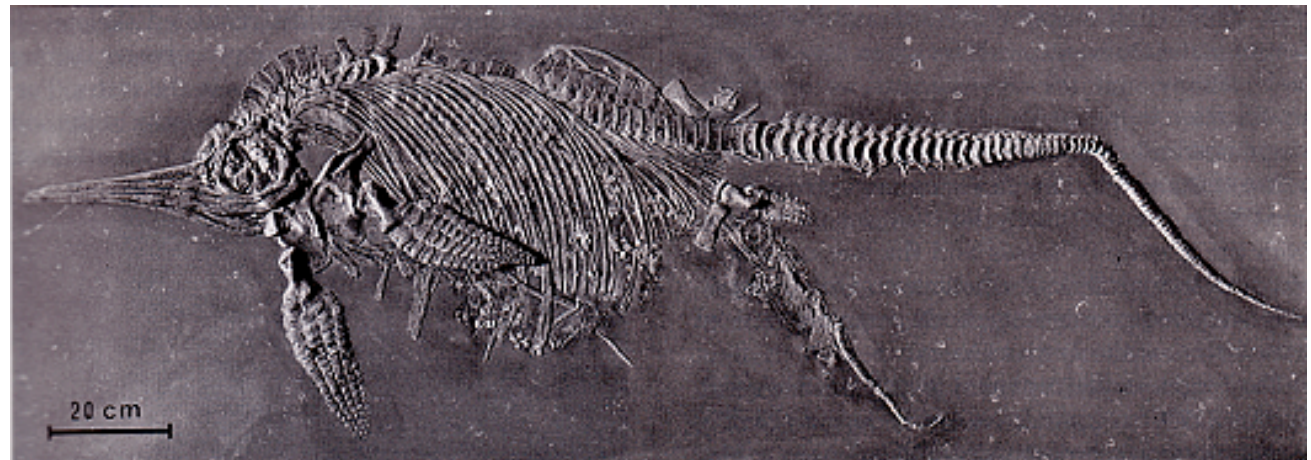
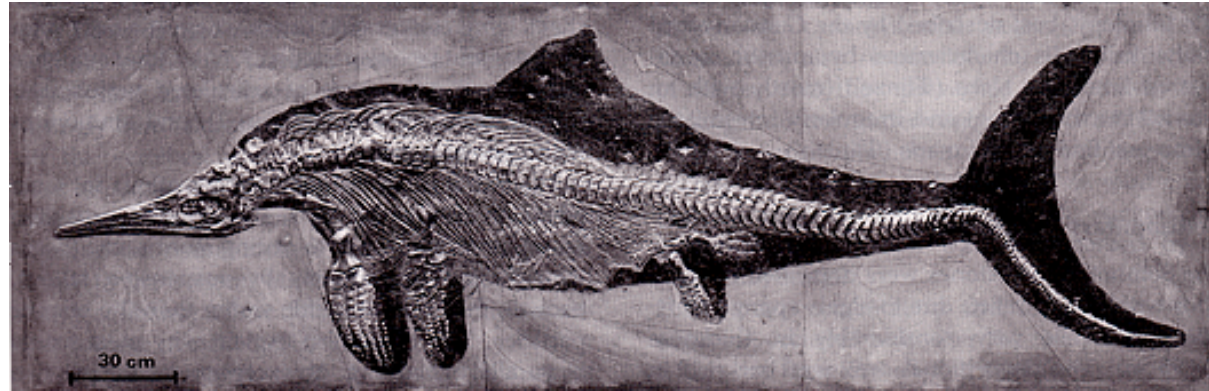


Holzmaden



- (Lower Jurassic, Swabia, Germany)
- Environment: deep water black shale
- Preservation: carbonized films of the soft tissues around skeletons of marine vertebrates - stagnation deposit
- Significance: preserves anatomical details otherwise undetectable from skeletons of ichthyosaurs (dorsal fins, caudal fin, etc.). Because of high abundance of pregnant females, suggests that this was a birthing region.

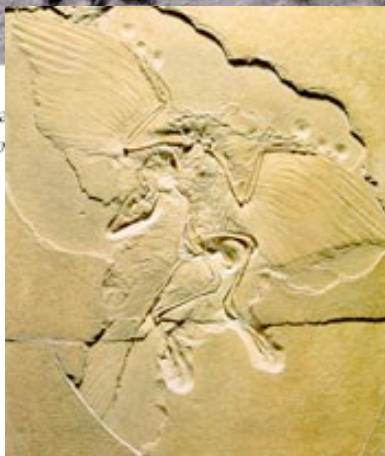
Holzmaden



Solnhofen Lithographic Limestone



Fig. 1 A cha...
decapod *Eryon*... the



Well preserved soft parts (the feathers of the first birds) and also detailed preservation of skeletal parts. The Late Jurassic Solnhofen lagoon was hypersaline with a microbial mat on the bottom. This is a stagnation deposit where all specimens are flattened.

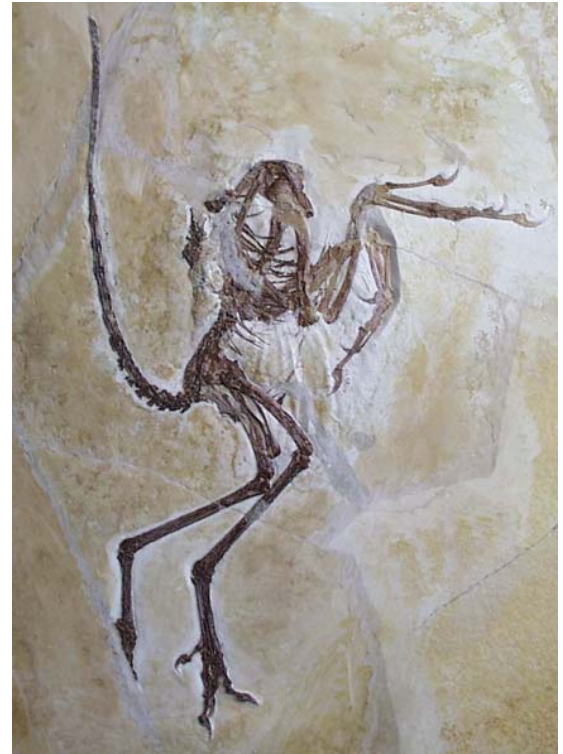
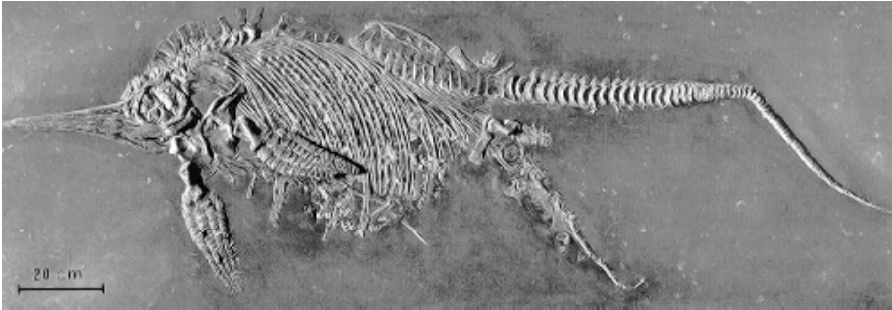
Directly postmortem fossils were cemented by contact with the cyanobacterial mat. This prevented the carcasses from sinking into the soft mud.

Then concentration and compaction of sediment occurred around the fossils, which are always flattened.

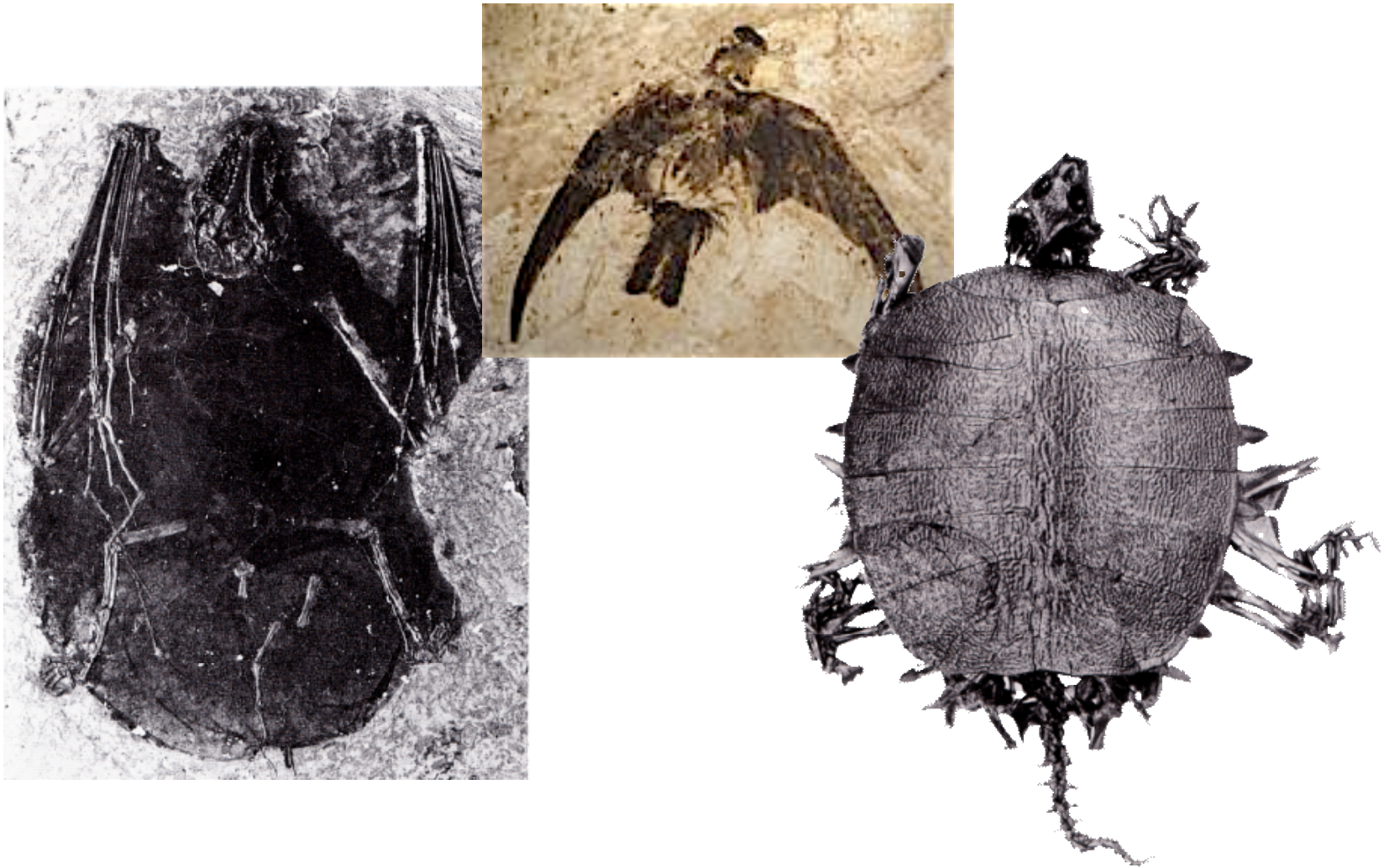
Aragonite was dissolved shortly after burial, leaving soft parts intact. Soft parts are well preserved - the ink of squids is so unchanged it can be mixed with water and used as ink.

Animals were washed in from nearby normal areas and most died instantly.

Significance: shows diversity of marine organisms around the time of the origin of "modern" style invertebrates. Also, high diversity of pterosaurs (flying reptiles). Locality for the early feathered dinosaur (basal bird) *Archaeopteryx lithographica*.

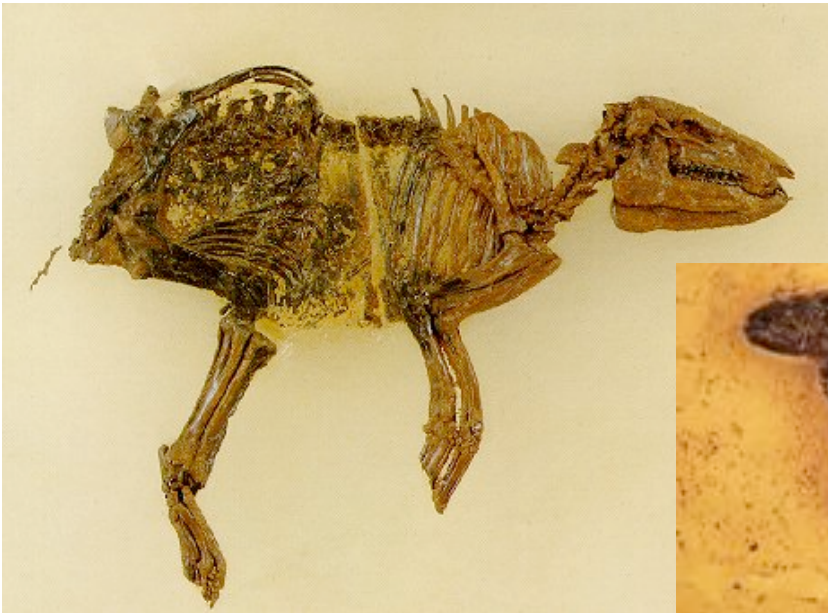


Grube Messel



Incredible limnic stagnation deposit with rich concentrations of many terrestrial vertebrates.

Grube Messel



Grube Messel



Grube Messel

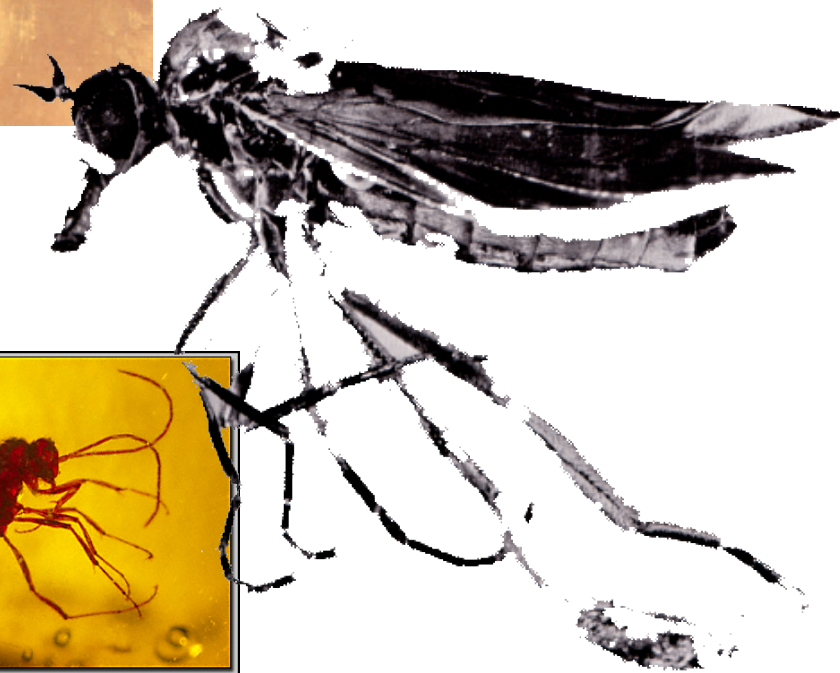


Florissant, Colorado

To the west of Pikes Peak, Colorado, exposures of Eocene lake deposits preserve a spectacular fauna and flora ranging from microscopic ants to redwood stumps several feet in diameter. About 45 million years ago, a stream in a prehistoric valley was dammed by lava flows, forming a series of lakes. The fine sediments accumulating in these lakes along with ash from periodic volcanic activity provided an excellent mode of preservation for insects and plants.



Amber (Baltic Coast and Costa Rico)



Amber (Baltic Coast and Costa Rico)

