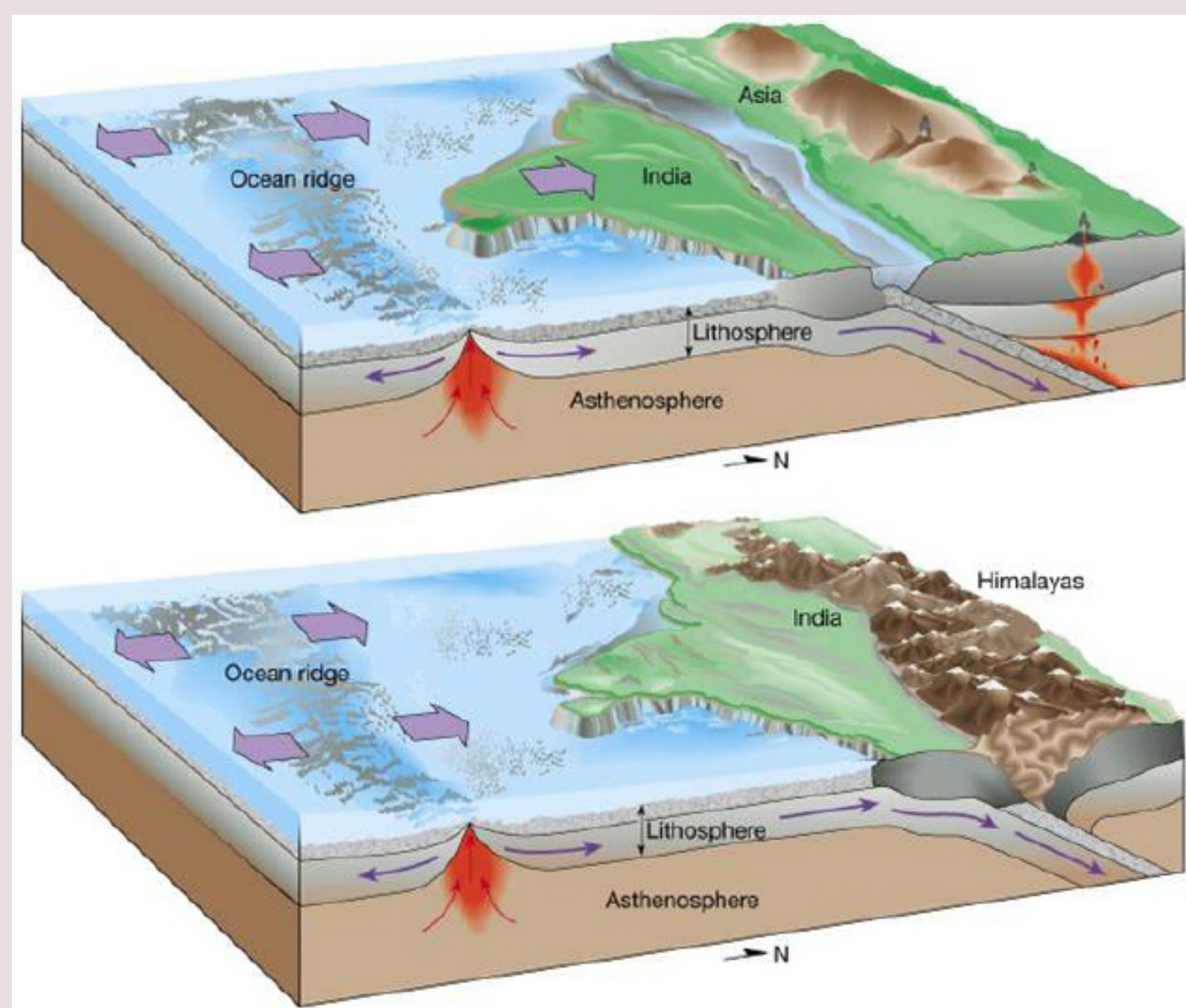


THE FIRST SUPERCONTINENT — 1.1 BILLION YEARS AGO

Rodinia — Russian for “homeland”

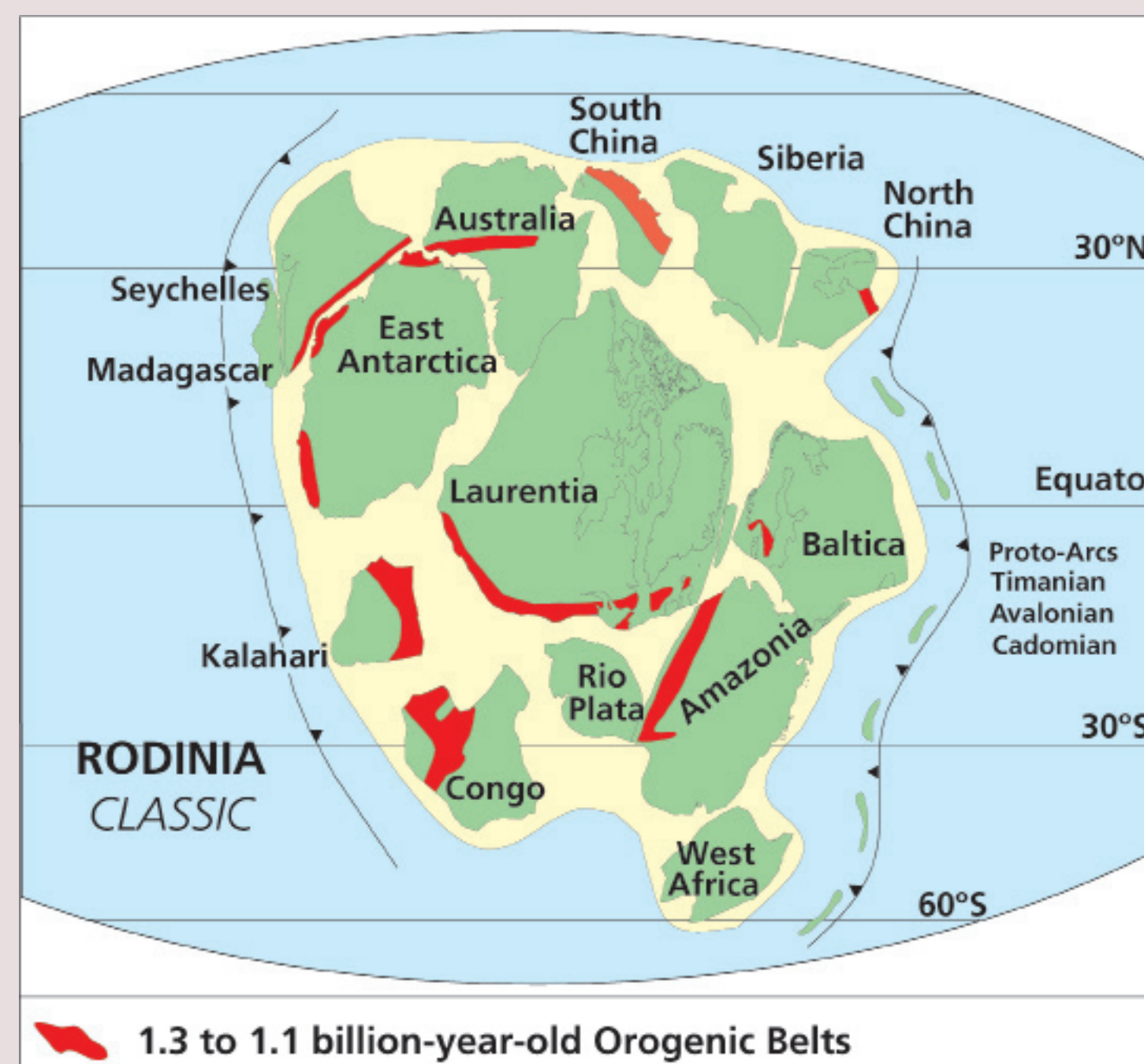
Sometime between 1.2 and 1 billion years ago, the supercontinent **Rodinia** formed. It was surrounded by an ocean called **Mirovia**. Three or four existing continents collided in a large mountain-building episode, called the **Grenville Orogeny**. When two continents collide, neither will sink (as they are both low-density continental crust, like corks bobbing in the ocean). Instead, they thrust over one another near the surface and fold at depth (where rocks are hotter) to form **fold-and-thrust mountains**. Rocks trapped in this **collision or suture zone** are highly metamorphosed by high temperatures and pressures. A similar thing is happening today where India has collided with Asia and created the Himalayan Mountains. Approximately one billion years ago, a Himalayan-type collision occurred (of much greater magnitude since all continents collided). The rocks formed in this process became the suture zone that joined the continents into one.



India collides with Asia, creating the Himalayan Mountains and the Tibetan Plateau. A similar process brought all the continents together 1.2 billion years ago when Rodinia formed. © Prentice Hall Publishing

It is difficult to try to reconstruct plate motions so far into the past, as in the interim, new oceans have formed and subducted; new mountains have grown and eroded; and continents have split apart, collided again, and eroded. Based on the geometry of the Grenville Orogeny rocks (currently distributed across most of the world's continents) and paleomagnetic evidence, we try to reconstruct the size, shape, and location of ancient Rodinia.

Paleomagnetism is a record in a rock of its location on the planet relative to the magnetic north pole when the rock formed. Paleomagnetic data tell us the latitude of formation of rock, in this case of the rocks formed when Rodinia came together. Unfortunately we do not have good paleomagnetic evidence for the cores of each of today's continent, so we have to put our puzzle together best we can with what we have.

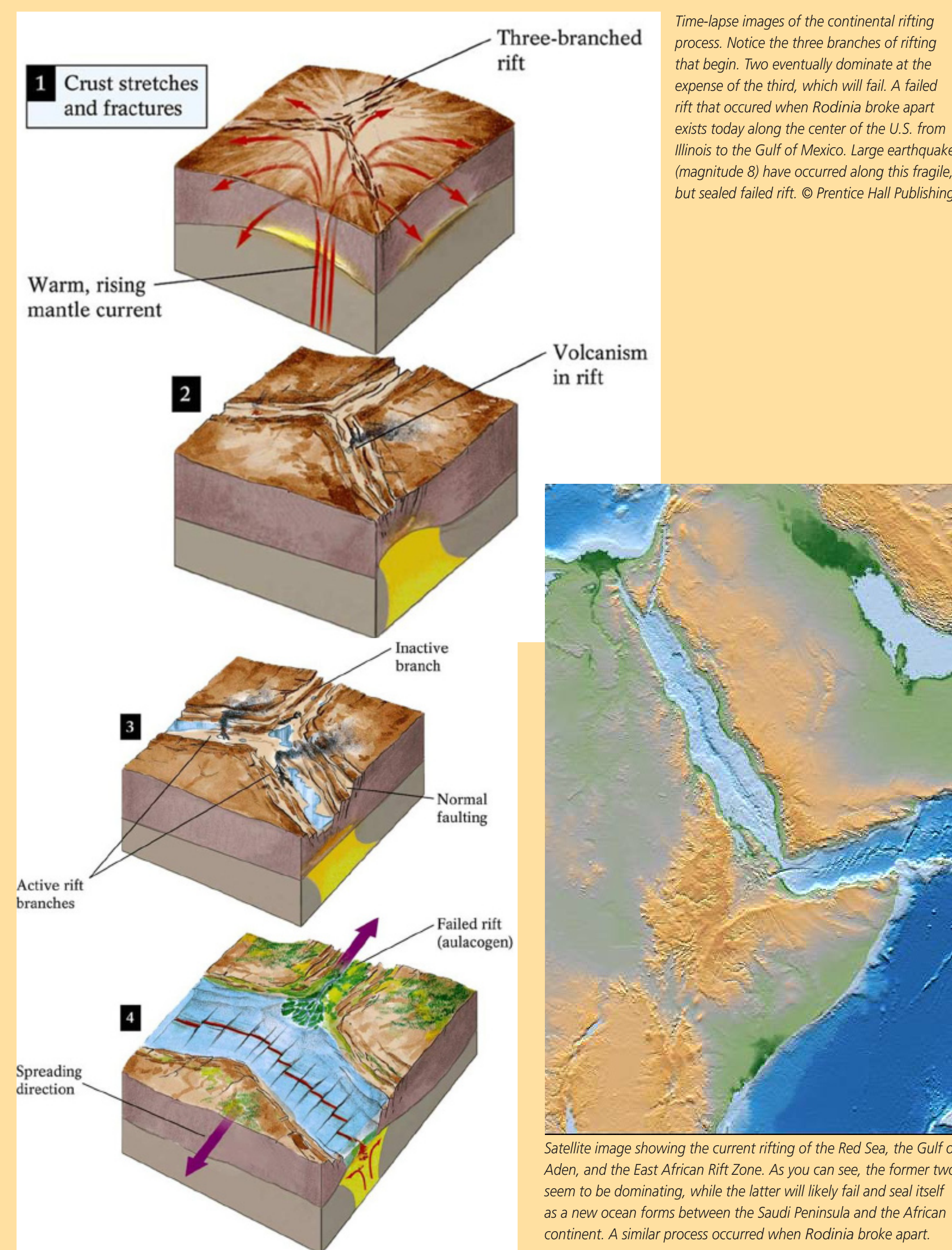


The classic reconstruction of supercontinent Rodinia, which came together in a global collision event, 1.2 to 1.0 billion years ago, forming a number of mountain-building (orogenic) belts where continents collided (including the Grenville Orogeny rocks). Rodinia existed as a single continent for about 250 million years. (KEY: Laurentia = proto North America; Baltica = proto Eastern Europe; Rio Plata and Amazonia = proto South America; Kalahari, Congo, and West Africa—here widely dispersed—eventually become proto Africa.) Images © Terje Torsvik.

Based on current data, the most accepted theory is that the Rodinia supercontinent was centered across the equator and extended from about 60°N to 60°S. The western margin of North America was sutured to what we know today as Australia and Antarctica and Northern China. Today's Siberia, South America, and Africa are distributed around these, but, again, there is a lot of debate and competing ideas about where.

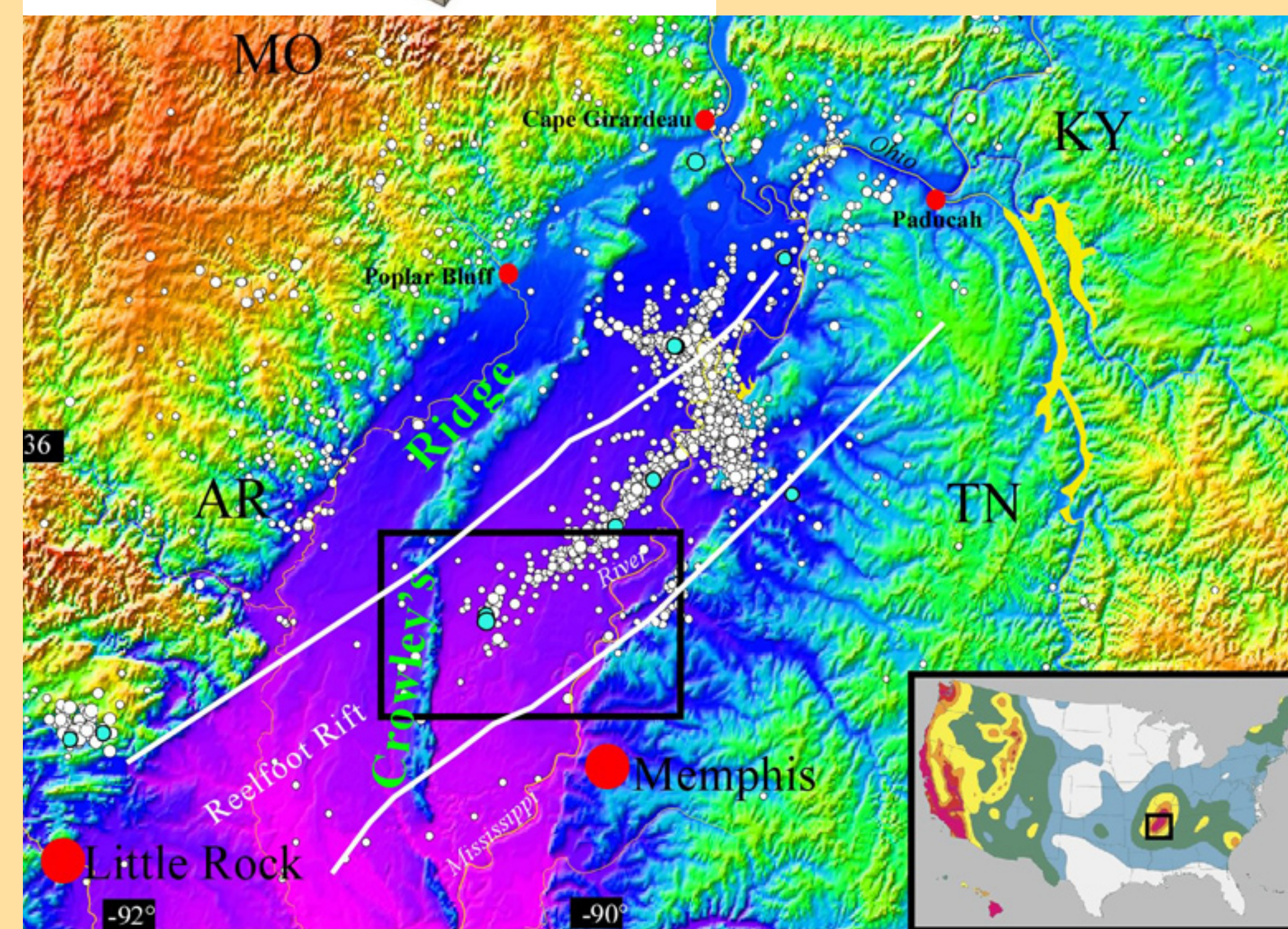
Rodinia breaks up

It is thought that Rodinia, as a single supercontinent, persisted over 250 million years. It began to rip apart between 850 and 800 million years ago. Based on studies of rifting occurring today (in the **East African Rift Zone**), scientists believe that continents start to break apart at single points that then rip open in three directions. (Imagine tearing a tennis ball by puncturing it from the inside out with a nail, creating three rips that each tear open like a banana peel.) Over time, two of the rips succeed, and one fails. **The Reelfoot Rift**, which has been detected using geophysical instruments, extends from the Gulf of Mexico to Illinois and is a failed, third rift from the Rodinia breakup. The active New Madrid earthquake zone in Missouri occurs along the Reelfoot Rift. Large earthquakes sometimes occur here because of the fragile nature of the rift, even though sealed.



Time-lapse images of the continental rifting process. Notice the three branches of rifting that begin. Two eventually dominate at the expense of the third, which will fail. A failed rift that occurred when Rodinia broke apart exists today along the center of the U.S. from Illinois to the Gulf of Mexico. Large earthquakes (magnitude 8) have occurred along this fragile, but sealed failed rift. © Prentice Hall Publishing

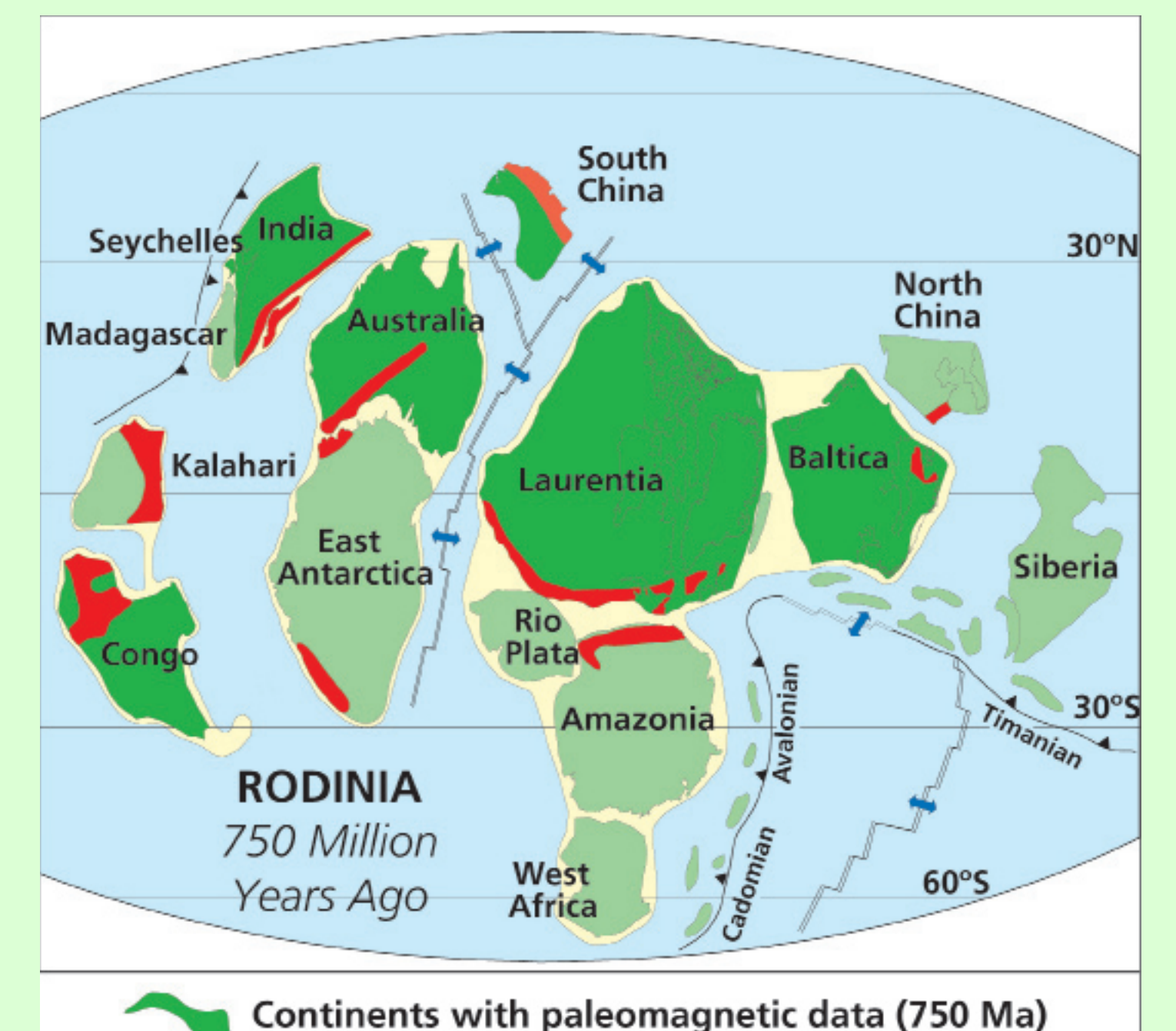
Satellite image showing the current rifting of the Red Sea, the Gulf of Aden, and the East African Rift Zone. As you can see, the former two seem to be dominating, while the latter will likely fail and seal itself as a new ocean forms between the Saudi Peninsula and the African continent. A similar process occurred when Rodinia broke apart.



Map of the middle Mississippi River valley in the central U.S. showing topography (purple at about 47 m up to orange at about 360 m elevation). White heavy lines bound the Reelfoot Rift. White and blue circles are locations of small, but continual earthquakes in this area. Several of the largest historical earthquakes to strike the continental U.S. occurred in the winter of 1811 & 1812 along the New Madrid seismic zone, which stretches from just west of Memphis, Tenn., into southern Illinois. Future seismic activity in this zone threatens the Mississippi, Ohio, and Wabash River valleys. Image from USGS.

Proto-California

When Rodinia began to split apart, Australia and East Antarctica rifted away from the western margin of Laurentia (or proto-North America). This margin was the precursor of today's west coast (proto-California). The ocean **Panthalassa** (Greek for “all seas”) began forming, separating them further and further from each other.

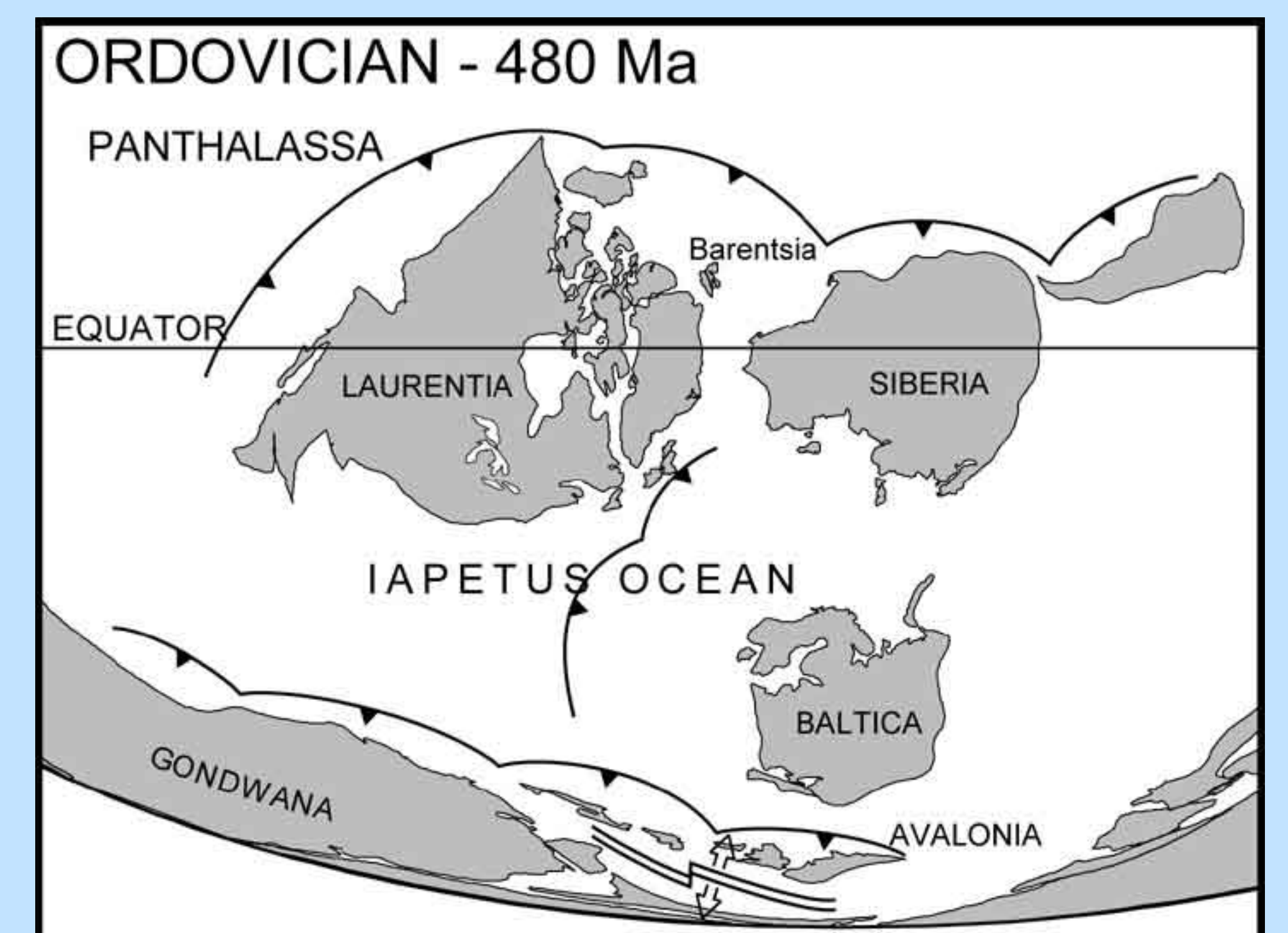


Reconstruction of Rodinia as it was breaking apart 750 million years ago, based on paleomagnetic data for key continental cores. The Panthalassa Ocean formed between Laurentia (proto North America) and East Antarctica and Australia. (KEY: Laurentia = proto North America; Baltica = proto Eastern Europe; Rio Plata and Amazonia = proto South America; Kalahari, Congo, and West Africa eventually become proto Africa.) © Terje Torsvik

Header image shows the collisional mountain belt in Glacier National Park. Although the mountain-building event that caused these mountains is more recent than Rodinia, the rocks that are being pushed up were formed along the western margin of Laurentia while it was part of the Rodinia supercontinent. Photo by Katryn Wiese ©

What was Gondwanaland?

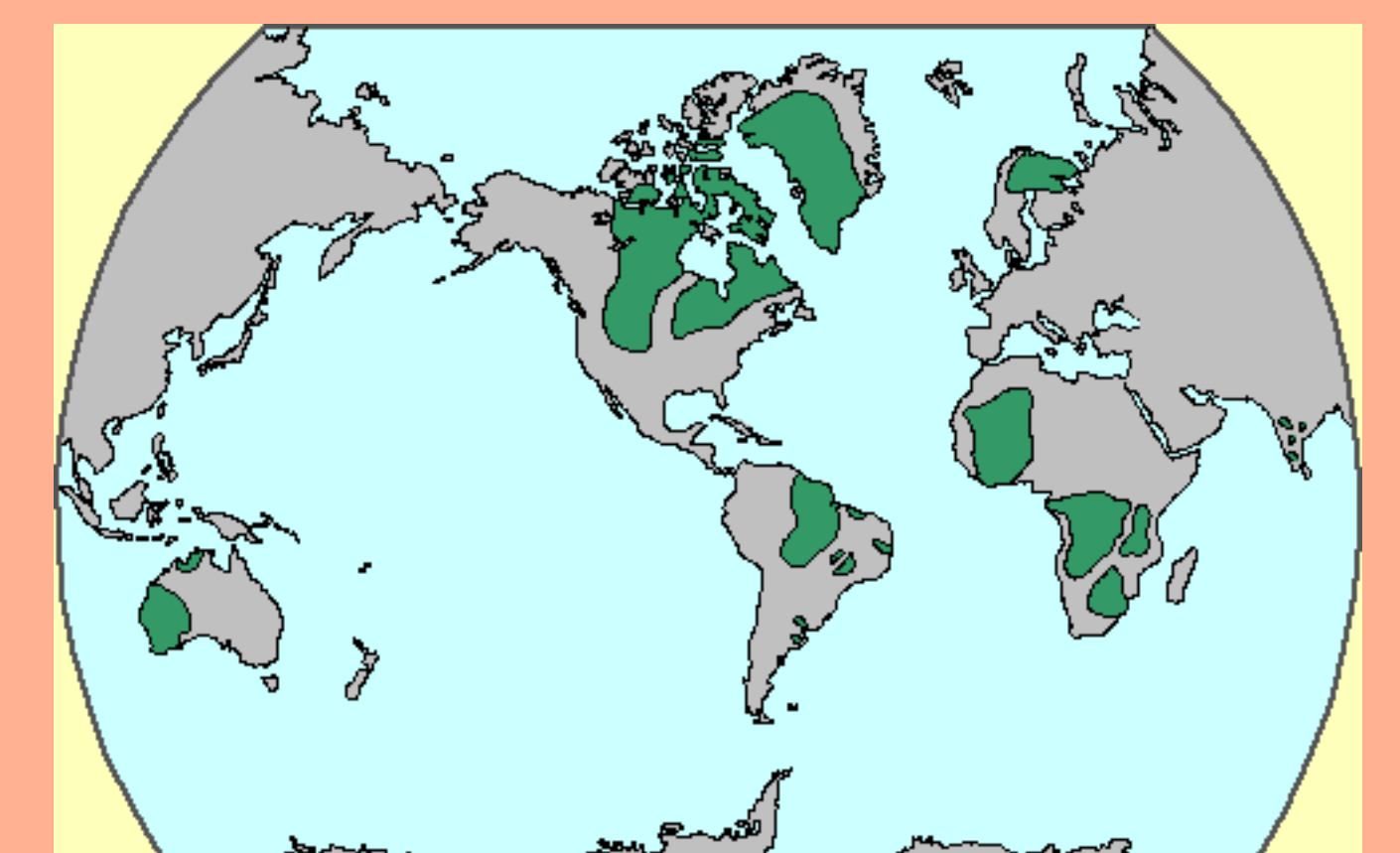
Northern Europe and South America rifted away as late as 600 to 550 million years ago, opening the **Iapetus Ocean** between them. Approximately 540 million years ago, South America collided with Antarctica and Australia and Africa, creating a large continent called **Gondwanaland** in another large mountain-building event called the **Pan-African Orogeny**. Rocks from this event are now distributed across all those continents.



Laurentia rifts apart on its eastern margin from Baltica (proto Eastern Europe) and Gondwanaland (proto Australia, Africa, and South America), with the Iapetus Ocean forming between them. © C. R. Scotese, PALEOMAP Project (www.scotese.com)

Where can we find Rodinian rocks today?

The ancient rocks of Rodinia, which we study to learn its story, are distributed across all the continents in ancient **shields** or cratons. They are the oldest cores of all continents.



By 2.5 billion years ago, about 25% of the current continental crust had formed. These most ancient land masses, or shields, are shown in green on this sketch (in their current locations, not where they formed). They represent the cores of the landmasses that collided to form Rodinia. © www.jamestown-ri.info