k20 The Grenville mobile belt < 0.9-1.3 Ga >

When I use a word, it means just what I choose it to mean. —Humpty Dumpty.[1]

Consensus is that the Grenville mobile belt (***Figure k20.1***), and its now severed continuations through southern Scandinavia, southern Australia, and Bunger Hills in Antarctica,[2] is composed of an inner allochthonous monocyclic belt of mostly Mesoproterozoic rocks, within an allochthonous polycyclic belt of transported Mesoproterozoic and Paleoproterozoic rocks that is separated by the Allochthon Boundary Thrust (ABT) from an outer parautochthonous belt of Mesoproterozoic and Archean rocks of once Laurentia-to-be's southern margin. The Alice-through-the-looking-glass-word *parautochthonous* means that the rock units referred to are intermediate in tectonic character between *autochthonous* and *allochthonous*. Which is to say that if the rocks have been *moved from the place of their origin* (allochthonous), then they have not been greatly moved from (are *near*: para) where they could have *formed in place* (autochthonous).[3]

William Edmond Logan (1798-1875): "In stature, Logan was about five foot nine inches, and possibly weighing 150 pounds. Walking was annate!! ... While living in London and Swansea, he walked to work each day, possibly four to six miles. His field measurements in the Canadian bush were made by counting steps using a compass, with a mercury barometer for elevation." —C. Gordon Winder.[5]

Attempts to explain the features of the Grenville have humbled many. **William Logan**, who should be remembered for being the first to determine that coal beds (of Carboniferous age in Wales) *are* autochthonous ("His careful mapping and stratigraphic studies of Welsh coal seams showed that coal developed in place from swamps, in his words, 'in the *Stigmaria Ficoides* we have the plant to which the earth is mainly indebted for those vast stores of fossil fuel which are now so indispensable to the comfort and prosperity of its inhabitants'")[4] is remembered less kindly for opposing evolution, opposing Agassiz's glacial theory,[6] and for having influenced many, in his capacity as first director of the Geological Survey of Canada, to the (false) Wernerian principle that rocks that are granitic and greatly contorted are older than those that are neither. In 1863, he published his opinion that the Precambrian Grenville granite-gneisses are the oldest shield rocks[7] when they, as he was belatedly to suspect, and we know, are in their metamorphic age the youngest. But, that Logan was a "greater scientist" is evidenced, in a manner that cannot be disparaged, by his recruitment for the Survey of those who were describing from ancient rocks in the western Great Lakes area geological field evidence that countered the principle that the oldest rocks are granitic.[8] Demonstrating Canadian minerals at the Crystal Palace to Queen Victoria in 1851, he properly flattered her intelligence. She knighted him in 1856.[9]

Metamorphic recrystallizations of the Grenville mobile belt ceased 950 Ma. These recrystallizations, recorded everywhere within the Grenville mobile belt by K-Ar radiometric mica dates, did not occur outside of its area. What, as Frank Dawson Adams (1859-1942) proposed in 1896,[10] we see now parallel the St. Lawrence River, are the roots of a once fold-mountain range.

The metamorphically youngest part of the Grenville mobile belt is called the *Grenville Front Tectonic Zone*.[11] This is a major structural and metamorphic discontinuity in which brittle fracture is transitional at the low grade greenschist facies at the contact with the unaltered Shield rocks, to high grade flow-folded metamorphic rocks of the Grenville orthogneisses which are metamrophosed granitic plutonic rocks (by contrast, paragneisses are gneisses formed from sedimentary rocks). Extending out of the Grenville are pegmatites. Extending into the Grenville Front Tectonic Zone are

1.267 Ga Mackenzie-Sudbury Dikes. These, with no lateral offset, exist there fragmented, and metamorphosed at the amphibolite facies.

The Grenville Front Tectonic Zone is much intruded by granites in which nappes are traced out by paragneiss schleren and layers with a metamorphic age of deformation 1.12-1.16 Ga. The paragneisses called the *Flinton Group* were originally shelf sandstones, shales, and carbonates, that accumulated 1.25-1.3 Ga. The nappes record compression in a NE direction (as now oriented) due to the oblique collision (transpression) that brought into place the main area of the Grenville mobile belt. A geochronological finding by R. M. Easton in 1985 is that crust either side of the Grenville front was in place and stabilized 1.61 Ga.[12] The Grenville Front Tectonic Zone, by the evidence of its geology, is not a suture and was the margin of once Laurentia-to-be that became involved in continent-continent collision. As such, it is parautochthonous terrane.

The Grenville mobile belt is mostly part of the margin of a continent that collided with the southern margin of once Laurentia-to-be and then moved away. The area that it left, until that time, had been undergoing orogeny. Its paragneisses (Grenville Supergroup) were intruded by great volumes of granite 1.724 Ga. These paragneisses (quartzites, high-grade gneisses and marbles) were originally metamorphosed 1.750-1.9 Ga (Penokean orogeny). As such, this area is an allochthonous terrane.

Unrelated to these events, and inserting itself on the craton side 1.85 billion years ago, was a giant impactor—inferred to be so by **Robert Sinclair Dietz** (1914-1995) in 1962 [13] from the ring-shape of formation outcrops about the now town of Sudbury, central Ontario, and from his follow-up finding in 1964 of shatter cones in the surrounds.[14] Other surviving "astrobleme" ("star-wound") evidence, is a ring outcrop of 200-meter thick "impact melts" of the Onaping fm which contains mafic and ultramafic rocks in which, while molten for a duration of 250,000 years before cooling solidification, was gravitational differentiation from lighter silicates of denser nickel-copper-PGE (platinum group elements) sulfide ores. Erosionally truncated to a depth of 4 km, the once crater, Richard Grieve has estimated, was between 250 and 300 km across.[15] ❑

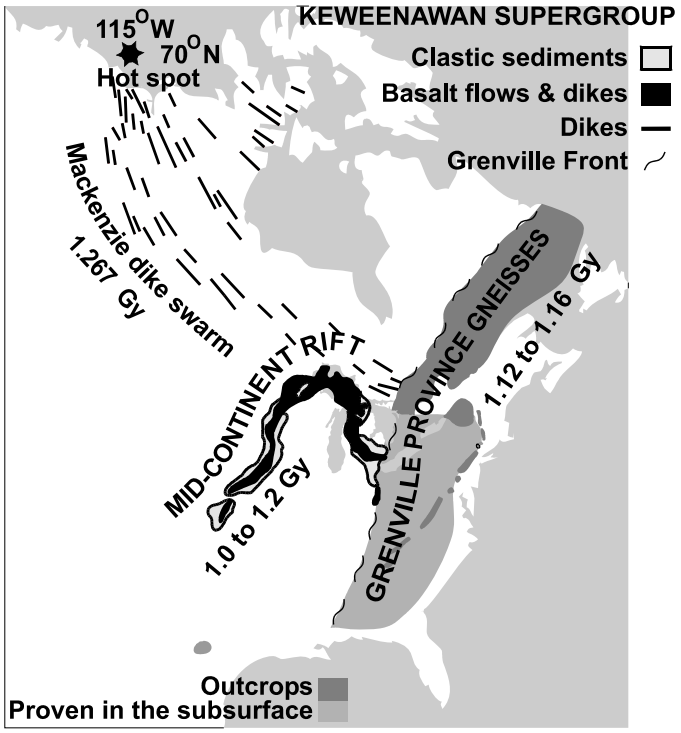

Figure k20.1 [16] Map showing the location in North America today of the Grenville Mobile Belt gneisses that record a late-Middle Proterozoic continent-continent collision.

The Middle Proterozoic "Mid-Continent Rift" (aulacogen) formed in from the southern margin of Laurentia-to-be 1.0-1.2 Ga.

The Grenville Front Tectonic Zone is a zone of metamorphism that incorporated the southern margin of once Laurentia-to-be 1.12-1.16 Ga. Added then, southeast of, and along the line of, the Grenville Front Tectonic Zone, was the Andean-type margin of a continent that collided and then split away.