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Transparent gemstones and the supercontinent cycle

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Certain hard (H≥6) normally opaque minerals occasionally crystallize as transparent crystals ("CCGs", for Crystalline Colored Gemstones). Such crystallization occurs under conditions that did not exist before the last supercontinent cycle.
• One set of gem-forming conditions arises during continent-to-continent collisions and the amalgamation of continents.
• Another, producing distinctively different gems, comes into existence during crustal extension and continental break-up.

Diamonds and those emeralds and alexandrites that formed in contact metamorphic deposits where crystal growth was cushioned by massive mica are excluded as special cases. Beryl-topaz deposits (Volodarsk, Ukraine; Luumäki, Finland) are also special cases with crystal growth in watery bubbles cushioned by still-viscous granitic magma. Quartz gems are excluded as a matter of convenience. Occurrences in Greenland are provisionally excluded.

Type-1 CCGs form at depth with greatly elevated temperature. Elevated temperature allows minerals to crystallize higher in the crust, hence with lower constraining pressure, thereby allowing gem-quality growth.
The requisite heat is produced by friction when and where one continental plate begins to pass beneath another, as in the Himalayas, Hindu Kush, Pamirs, Urals, and eastern Kenya-Tanzania. An arcuate scar with circular curvature is present in each of these CCG-producing areas, presumed vestiges of the Late Heavy Bombardment (c.4100–c.3800 Ma). Slanting zones of crustal weakness guided down-going continental plates. Multiple CCG deposits formed in weakened crust just inside rejuvenated arcuate scars, which was also where greatest heating occurred.
Aside from the special cases, the world's oldest CCGs formed during the Pan-African polyphase episode of continent-to-continent collisions, c.640–c.520 Ma. Such ages characterize CCG crystallization in eastern Africa, Sri Lanka, Madagascar, western Namibia, and eastern Brazil. These dates are interpreted as signaling the first oblique continent-to-continent collisions, or the first doublings of the continental crust. Type-1 CCGs are associated with the amalgamation of continents.

Type-2 CCGs are represented by blue-green-yellow magmatic (BGYmag) sapphires, the oldest of which crystallized <300 Ma. Such gems occur in eastern Australia, far-eastern Russia, eastern China, SE Asia, Rwanda, Cameroon, NW Kenya, Madagascar, France and elsewhere. These occurrences are associated with crustal extension and continental break-up.
The mode of formation of BGYmag sapphires is incompletely understood, but can be broadly outlined. During extension and continent break-up, high-density pure CO_2 is released from continental and mid-oceanic rifts, "an important mechanism for transferring deep mantle fluids towards the Earth's surface" (Touret and Huizenga, 2012).
When a CO_2 bubble-domain invades a silicic melt or magma containing Fe and Mg, the magma becomes oversaturated in aluminum (Guo et al., 1996). Exsolution forces crystallization of corundum crystals incorporating trace Fe and Ti that give characteristic BGY coloring. Corundum crystals are subsequently transported upward by alkali basaltic lava to which they adhere and which partially resorbs them (Baldwin, 2015). Gem-quality crystallization depends on cushioning of crystals growing within dense CO_2 fluid. When pressure varies, the change is transmitted equally in all directions, with no shearing or folding, but with production of color zoning where uptake of trace Fe and Ti did not keep pace with exsolution of aluminum.