The physical hydrogeology of orogenic-type gold deposits has been linked to ancient self-organizing processes such as earthquake-aftershock sequences and seismic swarms. During such active faulting, fracturing and cementation, permeability acts as a dynamic parameter, varying by 5-10 orders of magnitude over short timescales (months-decades). Here, we explore the spatial relationship between fault stepovers and orogenic-type gold deposits and demonstrate, using boundary element modeling, that large regions of damage can be generated around underlapping fault stepovers. Field evidence indicates that pulses of overpressured, gold-bearing fluids then migrate through the system, leading to multiple fracture and fault slip events in the damage zone and remarkably high but transient permeability. We develop time-integrated fluid flux calculations that account for both the large enhancement of permeability that occurs in earthquake-aftershock sequences and the rapid decay in permeability that occurs due to fault healing and cementation. Based on typical orogenic fluids with gold solubilities of 10-1000 ppb, we show that a moderately large goldfield of 5 Moz could form in as little as 1-2 seismic sequences, representing durations of just 10-1000 years. Similar rapid durations for goldfield formation have been inferred from different environments, including volcano sector collapse (e.g. Lihir, Papua New Guinea) and convective circulation in geothermal regions (e.g. Taupo Volcanic Zone, New Zealand). For orogenic-type deposits, successful deposit formation requires short windows of time when fluids evolve elevated concentrations of gold, nested within a longer duration self-organizing system.