

The Anthropocene — from Concept, to Geological Epoch, to 21st Century Science

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The Anthropocene concept was proposed in 2000 as Earth's newest epoch, a period during which humanity's impact on the planet has rivaled that of the great geological forces. Humans are changing the Earth's biophysical system — atmospheric and ocean climatology and chemistry, extent of snow cover, permafrost and sea-ice, glacier, ice-sheet and ocean volume, and indeed the hydrological cycle. Some changes are truly global, represented by similar temporal trends — atmospheric greenhouse gases, global surface temperatures, nitrogen fluxes to the coastal zone, and species extinctions.

From a sedimentology perspective, we note humans are now the largest force in the movement of sediment — greater than ice (4+ Gt/y), wind (~1.5 Gt/y) and water (12.8 Gt/y as particulates and 4 Gt/y in dissolved form). There are 568,000 abandoned mines in the U.S. alone, and millions more throughout the world. We mine 9 Gt/y of coal. Globally, aggregate production is 13 Gt/y, equal to the total sediment delivery to the global ocean by all rivers. Hydraulic cement production is 3 Gt/y, and global iron ore production is 2.2 Gt/y. The traces of humanity (e.g. petroleum wells, boreholes, deep-water wells) will last millions of years with borehole-lengths exceeding 50 Mkm. On average, one large (>15m high) dam has been built every day for the last 130 years, delaying the flow of freshwater to the ocean by weeks to months and trapping ~45 Gt/y of sediment within their reservoirs. Deltas are starved of sediment, and in combination with the mining of water, oil and gas, large deltas are sinking many times faster than sea level is rising due to climate change.

Human activity is leaving a pervasive and persistent signature on Earth. The appearance of manufactured materials in sediments, including aluminum, plastics, and concrete, coincides with global spikes in fallout radionuclides and particulates from fossil fuel combustion. Carbon, nitrogen, and phosphorus cycles have been substantially modified over the past century. Rates of sea-level rise and the extent of human perturbation of the climate system exceed Late Holocene changes. Biotic changes include species invasions worldwide and accelerating rates of extinction. These combined signals render the Anthropocene stratigraphically distinct from the Holocene and earlier epochs.

The Anthropocene concept has escaped its Earth System science confines to emerge as a new paradigm that embodies an altered human-environment relationship. Natural and social scientists, humanists, artists, educators and journalists now examine the concept from a variety of prisms. While the concept of the Anthropocene reflects the nature, scale and magnitude of human impacts on the Earth System, its true significance lies in how it can be used to guide attitudes, choices, policies and actions that influence the future, and how it manifest across different scales and within interlinked biophysical constraints and social conditions.