SECTION C

12

TIMESCALES

The timescales adopted in geomorphology fall well within the c.4.6 billion years of Earth history, with some being a mere season or even a single event. In addition to continuous timescales, discrete periods of Earth history have been utilized. Six hierarchical levels are formally defined geologically, and these embrace the external or allogenic drivers for the long-term intrinsic or autogenic processes that have fashioned the Earth's surface, some parts of which still bear ancient traces, whereas others have been fashioned more recently or are currently active. Contemporary problems demand attention to be given to recent timescales, the Quaternary and the Holocene, although these are less formally partitioned. Geomorphology-focused classifications have also been attempted with short, medium and long timescales conceived in relation to system states. An outstanding challenge is to reconcile research at one timescale with results from another.

Table 12.1 Historical naming of the geological epochs

Eon	Era	Epoch	Date	Origin
Phanerozoic	*Cenozoic*	Holocene	1885	3rd Int.Geol. Congress
		Pleistocene	1839	C. Lyell
		Pliocene	1833	C. Lyell
		Miocene	1833	C. Lyell
		Oligocene	1854	H.E. von Beyrich
		Eocene	1833	C. Lyell
		Palaeocene	1874	W.P. Schimper
	Mesozoic	Cretaceous	1822	W.D. Conybeare/J.Phillips
		Jurassic	1839	L. von Buch
		Triassic	1834	F.A. von Albertini
	Palaeozoic	Permian	1841	R.I. Murchison
		Carboniferous	1822	W.D. Conybeare/J.Phillips
		Devonian	1839	A.Sedgwick/R.I.Murchison
		Silurian	1839	R.I. Murchison
		Ordovician	1879	C. Lapworth
		Cambrian	1835	A. Sedgwick
Precambrian				Informal

For contemporary usage see Figure 12.1; the Holocene and the Pleistocene are now taken to be epochs within the Quaternary Period, and earlier epochs are within the Palaeogene and Neogene Periods in the Cenozoic.

Table 12.3 Archaeological and historical periods in Western Europe (dates are approximate)

Palaeolithic	Pre c.8800 BC
Mesolithic	8800–4900 BC
Neolithic	4900–2000 BC
Bronze Age	2000–800 BC
Iron Age	800–1BC
Roman	AD 1–450
Early Medieval	AD 450–800
Medieval	AD 800–1500
Early Modern	AD 1500–1800
Industrial/Modern	AD 1800–present

Table 12.4 Biological chronozones for the Holocene

Preboreal	11.7ka–11.5ka
Boreal	11.5ka–8.9ka
Atlantic	8.9ka–5.7ka
Subboreal	5.7ka–2.6ka
Subatlantic	2.6ka–present

The Blytt-Sernander sequence is used as a temporal framework and was initially based on northern European peat bog analysis, now refined through radiocarbon dating. Dates specified do vary, however.

RELEVANT ARTICLES IN *PROGRESS IN PHYSICAL GEOGRAPHY:*

Adams, J., Maslin, M. and Thomas, E. (1999) Sudden climate transitions during the Quaternary, *Progress in Physical Geography,* 23: 1–36.

French, J.R. and Burningham H. (2013) Coasts and climate: insights from geomorphology, *Progress in Physical Geography,* 37: 550–61.

Meadows, M.E. (2012) Quaternary environments: going forward, looking backwards?, *Progress in Physical Geography,* 36: 539–47.

Newson, M. and Lewin, J. (1991) Climatic change, river flow extremes and fluvial erosion – scenarios for England and Wales, *Progress in Physical Geography,* 15: 1–17.

Tooth, S. (2012) Arid geomorphology: changing perspectives on time-scales of change, *Progress in Physical Geography,* 36: 262–84.

UPDATES

The challenge of identifying discrete periods from continuously fluctuating data sets is demonstrated by Railsback et al. (2015). Should the boundaries be set at the crests of peaks and troughs, or at cross-over points, for example? How many 'periods' should be involved when there are very many minor fluctuations? Railback et al. provide some logical answers for Quaternary subdivision and nomenclature:

Railsback L.B., Gibbard P.L., Head M.J., Voarintsoa N.R.G. and Toucanne S. (2015) An optimized scheme of lettering marine isotope substages for the last 1.0 million years, and the climatostratigraphic nature of isotope stages and substages, *Quaternary Science Reviews*, 111: 94–106.

For those needing an up-to-date chart of Earth history, giving dates and names for Eras, Periods, Epochs and Ages, a frequently revised version is available online from the International Commission on Stratigraphy. The latest is available at www.stratigraphy.org.

Fossils have been central to the ordering and relative dating of sediments through much of Earth's history. For the immediate past, Zalasiewicz et al. (2014) explore the use of what they call 'technofossils', the artefacts produced through human technologies. These may help to unravel the sedimentation history of the Anthropocene. The paper emphasises the accelerating abundance of those made from materials rare or absent in nature, such as plastics or metals, as much as other artefacts or fossils long used in archaeology.

Zalasiewicz, J., Williams, M., Waters, C.N., Barnosky, A.D. and Haff, P. (2014) The technofossil record of humans, *The Anthropocene Review*, 1: 34–43.

How geological time periods get to be identified, for the Quaternary in particular, is discussed by Gibbard and Lewin (2016). Period identification is viewed as a cognitive and judgement-based process, essentially decided formally by experts, and liable to addition and revision as new knowledge and opinions emerge. Such a time framework is useful in navigating the past, for framing sets of characteristics at particular periods, and for identifying critical changes. As with much else relevant to geomorphology, this is a conceptually based process.

Gibbard, P.L. and Lewin, J. (2016) Partitioning the Quaternary, *Quaternary Science Reviews*, 151: 127–39.