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Supplemental Materials for: Phanerozoic shallow marine sole marks and substrate evolution

Lidya G. Tarhan

Department of Geology and Geophysics, Yale University, New Haven, CT 06511, USA; lidya.tarhan@yale.edu

METHODS

Sole mark occurrence data were collected by means of a survey of all scientific literature archived to Google Scholar and GeoRef and containing one or more of the following terms: bounce mark (or cast), brush mark (cast), current crescent, crescent mark (cast), flute mark (cast), groove mark (cast), gutter mark (cast), Kullingia (scratch circle), pot mark (cast), prod mark (cast), skip mark (cast), sole mark (cast), swing mark, tool mark (cast). All papers meeting these criteria and archived up through March 2018 were surveyed. In total, 327 distinct formation-level units (described in 381 papers from the sedimentological, tectonic and paleontological literature), containing shallow marine, sole mark-bearing facies were catalogued by geologic formation. This search was confined to the English-language literature. Conference abstracts were included only in cases where detailed sedimentological information was provided. These successions represent a range of depositional environments, from shoreface, nearshore and deltaic systems to shelf, platform and upper slope settings. Only those studies from which the specific formation-level unit bearing sole marks, and the depositional setting thereof, could be identified were included. In rare instances, units lacking formation-level identifiers and described only by higher-order categories (e.g., lithosedimentary group, belt or basin) were included as single entries—but only in such instances where, on the basis of age and geography, it was clear that there was no overlap with units already included in the database. Shallow marine units were further subdivided into two categories: 1) normal marine and lithified (*n* = 266) and 2) restricted, emergent or unlithified (*n* = 61). Subdivision into normal vs. non-normal marine was conducted in order to further elucidate first-order temporal trends in sole mark formation and preservation, by correcting for potential biases introduced by non-‘normal’-marine (restricted, brackish or periodically exposed) conditions associated with marginal marine settings, as these settings may (regardless of age) experience unusual environmental conditions (divorced from those of normal marine settings) promoting sediment cohesiveness. In addition, the small number of Quaternary shallow marine occurrences of sole structures were subdivided according to whether those sediments were lithified (*n* = 1) or unlithified (*n* = 5), as the unlithified sediments were, in most instances, modern seafloor sediments characterized by erosional gouges (incipient tool marks, flute marks and gutter casts) which had not yet been infilled or cast. As these have not yet experienced the ‘gauntlet’ of burial, preservation and lithification, unlithified Recent and modern (Quaternary) sediments were considered separately from lithified units. These literature data were also, for three units, supplemented by the author’s field-based sedimentological observations (e.g., Fig. 1; Supplementary Table 1; manuscripts in preparation). The age (to the level of Period), lithofacies, depositional environment and presence (and, where available, abundance and size) of all types of sole marks were noted (Supplementary Table 1).

Units crossing Period-level chronostratigraphic boundaries were assigned partial scores in each interval (e.g., an Ordovician–Silurian unit would be assigned an Ordovician score of 0.5 and a Silurian score of 0.5). Abundances of shallow marine formation-level units bearing sole marks were tallied and subsequently normalized to global Phanerozoic Period-level and Era-level rock area estimates, using the metrics of Raup (1976) (Period-level and Era-level) (Fig. 2A, DR1A), Wall et al. (2009) (Period-level) (Fig. 2B) and Peters and Husson (2017) (Era-level) (Fig. DR1B). The Period-level rock area estimates reported by Raup (1976), which are currently among the most precise and widely used global Period-level rock area estimates available, were originally derived from the calculations of Blatt and Jones (1975) which those authors calculated through randomized sub-sampling of global rock area from geologic maps. As Raup (1976) used time bin durations (Lambert, 1971) different from current definitions, Raup's (1976) Period-level km^2/yr estimates were un-normalized to rock area (10^6 km^2) estimates. Time bin durations used in this study were derived from Gradstein et al. (2012). For comparison, raw abundance data were additionally normalized to the Period-level estimates of marine sedimentary rock area of Wall et al. (2009), which were derived by those authors from a large-scale compilation of UNESCO global geologic maps, supplemented by lithologic data (see Wall et al. (2009) for a detailed discussion of how these estimates were generated). Raw abundance data were also normalized to Era-level global rock area estimates (calculated from Period-level estimates) reported by Raup (1976), as well as to Era-level global rock area estimates reported by Peters and Husson (2017, fig. S4) and derived by the latter authors from USGS global geologic map data (https://mrdata.usgs.gov/geology/world). As the rock area estimates of Raup (1976), Wall et al. (2009) and Peters and Husson (2017) were based upon different geologic map datasets and derived using different methods, the absolute rock area values (and thus area-normalized formation abundances) of each scheme also differ. However, as for any normalization scheme, it is the comparison between time bins subjected to the same normalization method which is most relevant, and all employed normalization schemes resulted in the same general and statistically robust temporal trend. Raup (1976) did not report estimates for Quaternary rock area, and Wall et al. (2009) did not report estimates for Pliocene or Quaternary rock area. Therefore, the six Quaternary shallow marine, sole mark-bearing units (five of which are unlithified and two of which are from restricted or emergent marginal marine settings) were not included in Fig. 2 or Fig. DR1A (but are included in Fig. DR1B and Fig. DR2), and the five Pliocene shallow marine, sole mark-bearing units were not included in Fig. 2B. Rock area was utilized as a normalization metric because rock area is inherently a factor of geologic time (e.g., time bin duration), sedimentary processes (e.g., the balance between sedimentation and erosion) and tectonic processes (e.g., subduction, accretion, crustal extension or contraction and uplift), all of which will substantially mediate the global areal extent of surviving outcrop available for survey. The overwhelming majority of sole mark identification occurs from field-based outcrop study (e.g., Supplementary Table 1 and references therein); therefore surficial rock area (rather than volumetric or mass-based metrics) was deemed the most appropriate metric for normalizing raw abundance data. Solely chronological normalization metrics (e.g., time bin duration; Fig. DR2) do not account for the influence of tectonic and sedimentary processes and are therefore subject to biases introduced by the ‘pull of the Recent’ (e.g., Pease, 1992; see Fig. DR2A), i.e., younger deposits have not yet experienced, relative to older successions, the geologic ‘culling’ associated with erosion, burial, lithification, tectonic deformation and subduction. Normalization to rock area is a widely employed method in the paleontological community, in which it has long been recognized that raw taxon abundance data will scale strongly to outcrop area (e.g., Pease, 1992; Wall et al., 2009; Close et al., 2017 and references therein). The temporal trends resulting from these calculations were further analyzed using regression analyses and Spearman rank-order correlation coefficients in order to assess the extent of correlation between sole mark frequency and geologic age; this correlation was found to be robust and statistically significant.

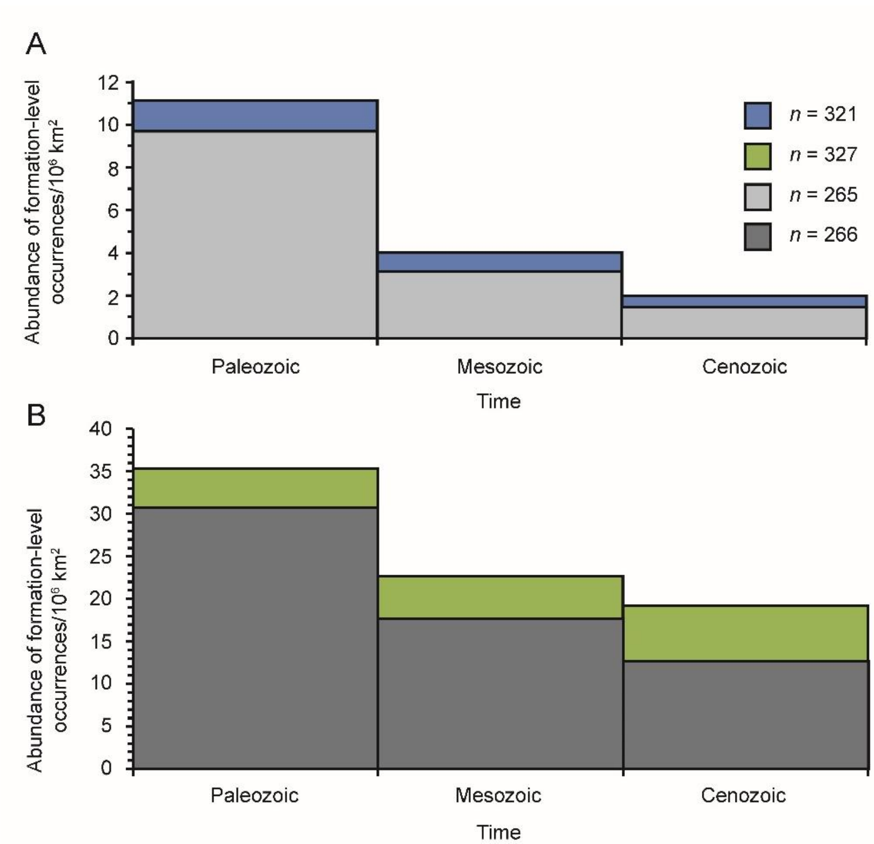

Figure DR1. Phanerozoic frequency of sole marks in shallow marine environments. Abundance of formation-level geologic units containing sole marks is reported, normalized to global rock area for each geologic Era. Blue and green histograms denote all shallow marine occurrences; gray histograms denote all shallow marine occurrences, excluding emergent and restricted settings and unlithified Quaternary sediments. Normalization to global rock area was calculated using the global rock area values reported in (A) Raup (1976) and (B) Peters and Husson (2017); the latter were derived from USGS global geologic map data (https://mrdata.usgs.gov/geology/world), as reported in Peters and Husson (2017, fig. S4).

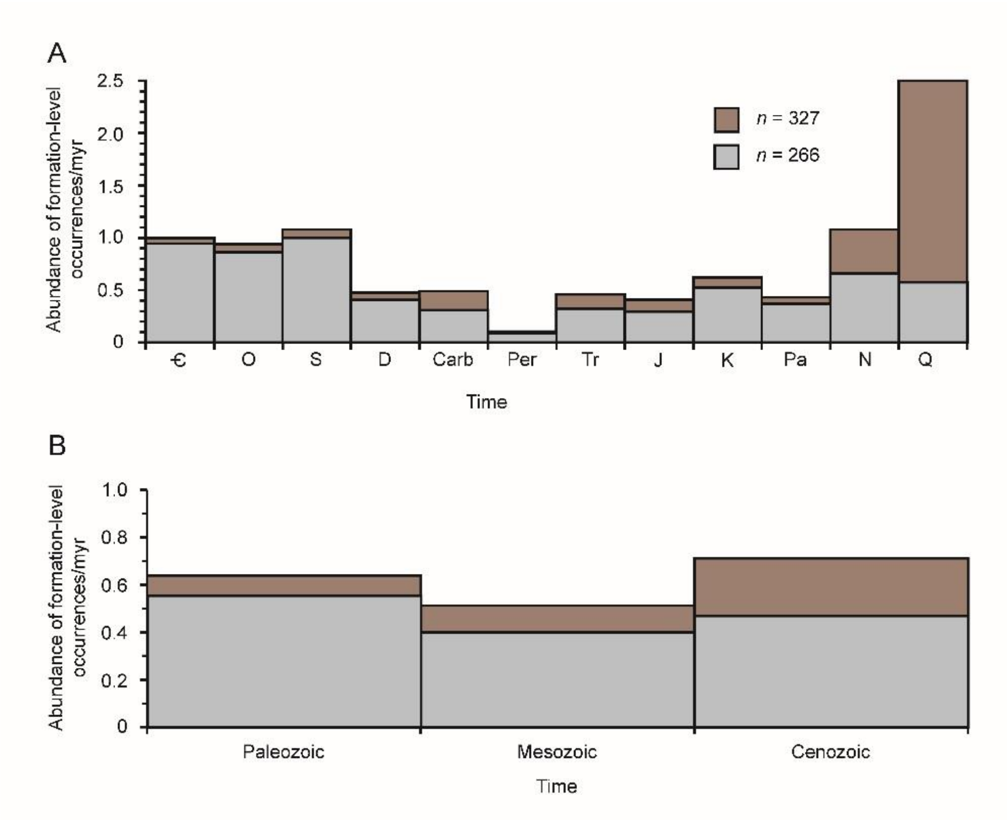

Figure DR2. Phanerozoic frequency of sole marks in shallow marine environments. Abundance of formation-level geologic units containing sole marks is reported, normalized to time bin duration, for each geologic Period (A) and Era (B). Brown histograms denote all shallow marine occurrences; gray histograms denote all shallow marine occurrences, excluding emergent and restricted settings and unlithified Quaternary sediments. Normalization to time bin duration was calculated using the values reported in Gradstein (2012). Recent (e.g., Quaternary) time-normalized abundances likely reflect the 'pull of the Recent.' See Fig. 2 in main text for Period abbreviations; Q, Quaternary.

Table DR1. Stratigraphic occurrences of Phanerozoic sole marks in shallow marine successions.

Table DR1. Phanerozoic shallow marine sole marks

Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Cambrian	USA	Abrigo Formation	Lower offshore, storm-dominated, above SWB	Gutter casts, tool marks	Present	Gutter casts 3-10 cm deep, 6-20 cm wide	Labaj and Pratt, 2016, *Journal of Sedimentary Research*
Cambrian	China	Abuqiehai Formation	Storm-dominated, offshore	Gutter casts	Present to common		Myrow et al., 2015, *Geological Society of America Bulletin*
Cambrian	USA	Adams Argillite	Shallow marine	Flute casts	Present		Gehrels et al., 1999, *Journal of Sedimentary Research* ; Demoulin and Harris, 2012, *AAPG Memoir*
Cambrian	Australia	Arumbera Formation	Deltaic, shelf	Tool marks, Kullingia (scratch circles), Arumberia (interpreted as flute mark)	Present		McIlroy and Heys, 1997, *Alcheringa* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Mapstone and McIlroy, 2006, *Precambrian Research*
Cambrian	Canada	Backbone Ranges Formation	Shelf, prodelta, between FWWB and SWB	Tool marks	Present		MacNaughton et al., 1997, *Journal of Sedimentary Research* ; MacNaughton and Narbonne, 1999, *Palaios*
Cambrian	Sweden	Borgholm Formation	Shallow marine	Tool marks	Abundant		Calner and Eriksson, 2012, *SEPM Special Publication 101*
Cambrian	Norway	Breidvika Formation	Shallow marine	Tool marks	Present		McIlroy and Brasier, 2017, *Geological Society, London, Special Publication*
Cambrian	Jordan	Burj Formation	Shallow marine	Flute marks	Present		Hofmann et al., 2012, *Journal of Paleontology*
Cambrian	USA	Cadiz Formation	Subtidal, above WB	Tool marks, potential scratch circle	Present		Waggoner and Collins, 1995, *Paläontologische Zeitschrift*
Cambrian	United Kingdom	Caered Mudstones and Flags (Gamlan Flags and Grits)	Shallow marine, proximal turbidites	Flute casts, groove casts	Common		Crimes, 1970, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cambrian	United Kingdom	Caerfai Series	Shallow marine	Flute casts, groove casts	Rare to present		Crimes, 1970, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cambrian	USA	Campito Formation	Shelf	Flute casts, sole marks, tool marks	Present		Mount, 1982, *Journal of Sedimentary Petrology*
Cambrian	USA	Carrara Formation	Subtidal, shelf	Tool marks	Rare to common (locally abundant)	Tool marks sub-mm- to mm-scale width, mm- to cm-scale length	Tarhan et al., 2015, *Nature Geoscience*
Cambrian	China	Chaomidian Formation	Storm-dominated platform	Gutter casts	Abundant		Chen, 2014, *Geologos*
Cambrian	Canada	Chapel Island Formation	Storm-dominated shallow marine	Gutter casts, groove marks, pot casts, flute marks, prod marks, Kullingia (scratch circles), tool marks, gutter casts	Present to common		Narbonne et al., 1991, *Journal of Paleontology* ; Myrow, 1992, *Journal of Sedimentary Petrology* ; Droser et al., 2002, *PNAS* ; Jensen et al., 2002, *Lethaia* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Mochizuki et al., 2014, *Journal of Paleontology* ; Tarhan et al., 2015, *Nature Geoscience*
Cambrian	USA	Deadwood Formation	Shallow marine	Pot and gutter casts, tool marks	Present		Pratt, 2002, *Geology*
Cambrian	Iran	Deh-Sufiyan Formation	Platform, subtidal, storm-dominated	Gutter casts, pot casts	Present		Bayet-Goll et al., 2015, *Facies*
Cambrian	South Africa	Dolkraals Formation	Wave-dominated shallow marine	Flute marks, tool marks	Present		Buatois et al., 2013, *Geology*
Cambrian	USA	Dotsero Formation	Storm-dominated inner detrital belt	Sole marks (groove casts, prod casts), tool marks	Abundant		Myrow and Chen, 2015, *Sedimentology*
Cambrian	USA	Erwin Formation	Lower shoreface to storm-dominated shelf	Tool marks, drag marks	Common		Cudzil and Driese, 1987, *Sedimentology*
Cambrian	Wales	Ffestiniog Beds	Shallow marine	Groove casts, flute casts	Rare (flutes) to common (grooves)		Crimes, 1970, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cambrian	Sweden	Gislöv Formation	High-energy, nearshore	Tool marks	Present		Álvaro et al., 2010, *Geological Magazine*
Cambrian	USA	Harkless Formation	Shelf to ramp	Tool marks	Common		Ahn and Babcock, 2012, *Sedimentary Geology*
Cambrian	Spain	Herrería Formation	Intertidal to subtidal	Flute casts, crescent marks, tool marks	Present		Owen, 1994, *Sedimentology* ; Alvaro et al., 2003, *Sedimentary Geology*
Cambrian	Czech Republic	Holsiny-Horice Formation	Lagoonal	Flute casts, skip marks, tool marks	Present		Kukal, 1995, *Journal of the Czech Geological Society*
Cambrian	Canada	Ingta Formation	Shelf, prodelta, between FWWB and SWB	Tool marks	Present		MacNaughton et al., 1997, *Journal of Sedimentary Research* ; MacNaughton et al., 1997, *Sedimentology* ; MacNaughton and Narbonne, 1999, *Palaios*
Cambrian	Ukraine	Khmelnitskiy Formation	Shallow marine	Kullingia (scratch circles)	Present		Droser et al., 2002, *PNAS* ; Jensen et al., 2002, *Lethaia* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Hogstrom et al., 2013, *Norwegian Journal of Geology*
Cambrian	Canada	King Square Formation	Inner to middle shelf	Medusichnites-type tool marks	Present		Hagadorn and Miller, 2011, *Atlantic Geology*
Cambrian	South Africa	Klipbak Formation	Wave-dominated shallow marine	Flute marks, tool marks	Present		Buatois et al., 2013, *Geology*
Cambrian	India	Kurgiakh Formation	Inner shelf, sub-FWWB	Gutter casts	Present		Myrow et al., 2006, *Journal of Sedimentary Research*
Cambrian	Argentina	La Laja Formation	Shallow subtidal	Gutter casts	Rare		Gomez et al., 2007, *Journal of Sedimentary Research*
Cambrian	Canada	Lake Louise Formation	Inner shelf	Gutter casts	Present		Desjardins et al., 2010, *Bulletin of Canadian Petroleum Geology* ; Johnston et al., 2017, *GSA Field Guide*
Cambrian	USA	Lodore Formation	Shallow marine	Tools, gutter casts	Present		Myrow and Tarhan, 2016 field observations

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Cambrian	Pakistan	Magnesian Sandstone	Shallow marine	Kullingia (scratch circles)	Present		Jensen et al., 2002, *Lethaia*
Cambrian	Wales	Manganese Beds	Shallow marine, semi-restricted	Groove casts	Present		Crimes, 1970, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cambrian	China	Mantou Formation	Offshore, storm-dominated shallow marine	Gutter casts	Common		Chen and Lee, 2013, *Sedimentary Geology*
Cambrian	Canada	March Point Formation	Shallow marine	Groove casts, Kullingia	Present		Tarhan, 2017, field observations
Cambrian	Antarctica	Mariner Formation	Shelf to platform	Furrow flute marks, flutes, grooves	Present		Andrews and Laird, 1976, *Sedimentary Geology*
Cambrian	Sweden	Mickwitzia Sandstone	Storm-dominated shelf	Flute casts, pot casts, gutter casts, tool marks (including Eophyton-type tool marks), prod marks, grooves, Kullingia (scratch circles)	Abundant (tool marks)	Tools are sub-mm to mm-scale in width	Jensen, 1997, *Fossils and Strata* ; Droser et al., 2002, *PNAS* ; Jensen et al., 2002, *Lethaia* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Savazzi, 2015, *Paleontological Research*
Cambrian	India	Nagaur Sandstone	Shallow marine	Current crescents	Present		Ahmad and Kumar, 2014, *Journal of the Palaeontological Society of India*
Cambrian	Canada	Nainlin Formation	Shallow to marginal marine, potentially emergent	Flutes, tool marks	Present		MacNaughton and Fallas, 2014, *Bulletin of Canadian Petroleum Geology*
Cambrian	USA	Orr Formation	Shallow marine	Gutter cast	Present		Evans, 2012, *AAPG Memoir* ; Miller et al., 2012, *AAPG Memoir*
Cambrian	India	Parahio Formation (Kunzum La Formation)	Deltaic	Groove marks, pot casts, gutter casts, probable scratch circle, flute casts	Common (grooves)		Myrow et al., 2006, *Journal of Sedimentary Research* ; Upadhyay and Parcha, 2012, *Himalayan Geology* ; Hughes et al., 2013, *Journal of the Palaeontological Society of India*
Cambrian	Canada	Petit Jardin Formation	Shallow marine	Groove casts, gutter casts	Locally abundant (grooves)		Tarhan, 2017, field observations
Cambrian	USA	Pioche Formation	Shelf, deltaic	Tool marks	Common to abundant		Tarhan et al., 2015, *Nature Geoscience*
Cambrian	Argentina	Puncoviscana Formation	Shallow marine	Flute casts, tool marks	Common		Buatois and Mangano, 2012, *Journal of Paleontology*
Cambrian	China	Qiongzhusi Formation	Deltaic, near SWB	Flute casts, groove casts, tool marks	Present		Hagadorn, 2002, in *Exceptional Fossil Preservation: A Unique View on the Evolution of Marine Life*
Cambrian	Iran	Soltanieh Formation	Distal tempestites, above SWB	Flute casts, tool marks	Common		Shahkarami et al., 2017, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cambrian	Antarctica	Springer Peak Formation	Shallow marine	Flute casts	Present		Castillo et al., 2017, *Geological Society of America Bulletin*
Cambrian	Canada	St. Piran Formation	Inner shelf to shallow subtidal	Gutter casts	Rare		Desjardins et al., 2010, *Bulletin of Canadian Petroleum Geology*
Cambrian	Antarctica	Starshot Formation	Shoreline, shelf, deltaic, wave- and storm-dominated	Flute marks, groove marks, prod marks	Rare (groove and prod marks) to abundant (flute marks)		Myrow et al., 2002, *Journal of Sedimentary Research* ; Goodge et al., 2004, *Geological Society of America Bulletin*
Cambrian	Sweden	Torneträsk Formation	Shallow marine	Kullingia (scratch circles)	Common		Jensen and Grant, 1998, *Norsk Geologisk Tidsskrift* ; Droser et al., 2002, *PNAS* ; Jensen et al., 2002, *Lethaia* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Axheimer et al., 2007, *Geological Magazine*
Cambrian	Spain	Torreárboles Sandstone	Nearshore to shallow shelf	Tool marks	Common		Tarhan et al., 2015, *Nature Geoscience*
Cambrian	Australia	Uratanna Formation	Shoreface to shelf	Kullingia (scratch circles), flute casts, tool marks	Common (Kullingia)		Mount, 1993, *Sedimentology* ; Droser et al., 2002, *PNAS* ; Jensen et al., 2002, *Lethaia* ; Droser et al., 2004, *Geological Society, London, Special Publication* ; Tarhan et al., 2015, *Nature Geoscience*
Cambrian	Canada	Vampire Formation	Shelf, prodelta, between SWB and FWWB	Tool marks	Present		MacNaughton et al., 1997, *Journal of Sedimentary Research* ; MacNaughton et al., 1997, *Sedimentology* ; MacNaughton and Narbonne, 1999, *Palaios*
Cambrian-Ordovician	Oman	Andam Formation	Storm-dominated shelf	Gutter casts	Rare to present		Millson et al., 2008, *AAPG Bulletin*
Cambrian-Ordovician	Ireland	Shelmaliere Quartzite Formation	Sub-shelf shallow marine	Flute casts	Rare		Shannon, 1978, *Proceedings of the Royal Irish Academy. Section B: Biological, Geological, and Chemical Science*
Ordovician	Scotland	Ardwell Flags	Shallow marine	Flute casts	Present		Hubert, 1966, *Journal of Sedimentary Petrology*
Ordovician	Portugal	Armorican Quartzite	Nearshore, above SWB	Crescent casts	Locally abundant	Crescent casts 4-13 cm wide, 2-6 cm long, up to 2 cm relief	Romano, 1974, *Comunicações dos Serviços Geológicos de Portugal*
Ordovician	Scotland	Barren Flags	Neritic	Flute casts, groove casts	Present	Grooves up to several feet long	Hubert, 1966, *Journal of Sedimentary Petrology*
Ordovician	Canada	Beach Formation	Wave-reworked fluvial-proximal shallow marine	Gutter casts	Common	Mm-scale and "small" gutters	Harazim and McIlroy, 2015, *Journal of Sedimentary Research*
Ordovician	USA	Bigby Formation	Shallow marine	Tool marks, gutter casts	Common (tool marks)		Holland and Patzkowsky, 1997, *Journal of Sedimentary Research*
Ordovician	England	Breadstone Shales	Shallow marine	Groove casts, bounce casts	Present		Curtis, 1968, *Proceedings of the Geologists' Association*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Ordovician	USA	Fairview Formation	Shallow marine	Gutter casts, tool marks (even on bed tops), groove structures	Abundant		Jennette and Pryor, 1993, *Journal of Sedimentary Petrology* ; McLaughlin and Brett, 2004, *Sedimentary Geology* ; Dattilo et al., 2008, *Canadian Journal of Earth Sciences* ; Brett et al., 2012, *GSA North-Central Section Fieldtrip* ; Smrecak and Brett, 2014, *Palaios*
Ordovician	USA	Garrard Formation	Shallow marine	Tool marks, groove structures	Common		McLaughlin and Brett, 2004, *Sedimentary Geology*
Ordovician	Canada	Georgian Bay Formation	Storm-dominated shelf, between FWWB and SWB	Gutter casts and tool marks (on bases of gutter casts)	Common (gutter casts)	Gutter diameters 4-15 cm, up to 15 cm relief	Kerr and Eyles, 1991, *Canadian Journal of Earth Sciences*
Ordovician	USA	Grant Lake Formation	Storm-dominated shallow marine	Kullingia (scratch circles), aligned potential current features	Present		Brandt et al., 1995, *Journal of Paleontology* ; Jensen et al., 2002, *Lethaia*
Ordovician	Libya	Haouaz Formation	Lower delta plain, fluvially and tidally dominated	Groove casts, current crescents	Common		Vos, 1981, *Sedimentary Geology*
Ordovician	USA	Hermitage Formation	Shallow marine	Tool marks, gutter casts	Common (tool marks)		Holland and Patzkowsky, 1997, *Journal of Sedimentary Research*
Ordovician	USA	Juniata Formation	Deltaic	Pot casts, tool marks	Present to common		Tarhan et al., 2015, *Nature Geoscience*
Ordovician	USA	Kope Formation (Economy Beds of Eden Formation)	Shallow marine	Epirelief and hyporelief tool marks, gutter casts, mud-filled scours, Kullingia (scratch circles), prod marks	Abundant		Jennette and Pryor, 1993, *Journal of Sedimentary Petrology* ; Holland et al., 2000, *Palaios* ; Holland et al., 2001, *Palaios* ; Jensen et al., 2002, *Lethaia* ; Dattilo et al., 2008, *Canadian Journal of Earth Sciences* ; Kirchner and Brett, 2008, Palaios; Brett et al., 2012, *GSA North-Central Section Fieldtrip* ; Smrecak and Brett, 2014, *Palaios* ; Meyer et al., 2016, *Palaios*
Ordovician	Sweden	Kyrkas Quartzite	Shelf	Flute casts, groove marks, sole marks, tool marks	Common to abundant		Dahlqvist, 2004, *Geological Magazine*
Ordovician	China	Lianglitage Formation	Carbonate ramp	Gutter casts	Present		Shen and Neuweiler, 2015, *Palaios*
Ordovician	USA	Liberty Formation	Shallow marine	Gutter casts	Present		Brett et al., 2012, *GSA North-Central Section Fieldtrip*
Ordovician	Canada	Lindsay Formation	Shelf	Gutter casts	Present to locally common	Gutters up to 10 cm "across"	Brett et al., 2006, *Palaios*
Ordovician	Spain	Los Puertos Formation	Shoreface, slope	Flute marks, tool marks	Common		Álvaro et al., 2009, *Geological Society, London, Special Publication*
Ordovician	Morocco	Lower Ktaoua Formation	Shallow marine	"Flute cast-like sole marks"	Present		Álvaro et al., 2007, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Ordovician	USA	Martinsburg Formation	Platform, shelf	Pot and gutter casts, tool marks	Present		Kreisa, 1981, *Journal of Sedimentary Petrology*
Ordovician	United Kingdom	Micklewood Beds	Shallow marine	Flute casts, groove casts, bounce casts	Present		Curtis, 1968, *Proceedings of the Geologists' Association*
Ordovician	Korea	Mungok Formation	Storm-dominated, subtidal, mid- to outer ramp	Gutter casts	Present	Gutter casts cm-scale	Kim et al., 2014, *Geosciences Journal*
Ordovician	USA	Murfreesboro Formation (Ridley Formation, Upper Carters Limestone)	Peritidal	Gutter casts	Rare		Holland and Patzkowsky, 1998, *Journal of Sedimentary Research*
Ordovician	Libya	not specified (Murzuq Basin)	Deltaic	Flute casts, gutter casts	Present	Flute casts up to m-scale	Girard et al., 2012, *Journal of Sedimentary Research*
Ordovician	Argentina	not specified (Santa Victoria Group)	Shelf	Flute cast, groove cast, current crescent	Present		Moya, 1988, in *The Southern Central Andes*
Ordovician	USA	Pierce Limestone (Lebanon Limestone)	Subtidal shallow marine	Tool marks, gutter casts	Common		Holland and Patzkowsky, 1998, *Journal of Sedimentary Research*
Ordovician	Canada	Powers Steps Formation	Storm-dominated nearshore, delta, shelf	Tool marks	Present to common	Tool marks sub-mm- to mm-scale width, mm- to cm-scale length	Tarhan et al., 2014, *Memoirs of the Association of Australasian Palaeontologists*
Ordovician	Canada	Redmans Formation	Tidal flat and barrier bar	Current crescents	Present		Ranger et al., 1984, *Canadian Journal of Earth Sciences*
Ordovician	Argentina	Santa Rosita Formation	Shallow marine	Tool marks, gutter casts, pot casts	Common		Buatois and Mángano, 2003, *Journal of South American Earth Sciences* ; Mángano et al., 2005, *Ichnos* ; Balseira et al., 2011, *Lethaia* ; Tortello and Estaban, 2014, *Journal of Paleontology*
Ordovician	India	Shian Quartzite Formation	Littoral	Flute casts, sole marks	Present		Bagati et al., 1991, *Sedimentary Geology*
Ordovician	Portugal	Sobrido Formation	Wave-influenced, open marine shelf	Groove casts	Common		Couto et al., 2013, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Ordovician	Mexico	Tiñu Formation	Storm-dominated shallow subtidal	Gutter casts	Present		Landing et al., 2007, *Geological Magazine*
Ordovician	Belgium	Unit 4: Lower Salmian (Stavelot Massif)	Shelf	Grooves	Present		Lamens, 1985, *Sedimentary Geology*
Ordovician	Morocco	Upper Tiouririne Formation	Shallow marine	Gutter casts, flute casts, groove casts	Common		Álvaro et al., 2007, *Palaeogeography, Palaeoclimatology, Palaeoecology*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Ordovician	Estonia	Vasalemma Formation	Wave-reworked shelf	Eophyton-type tool marks	Rare to locally abundant	Tool ridges <1 mm diameter, 8-9 ridges per cm	Vinn and Toom, 2016, *Neues Jahrbuch für Geologie und Paläontologie-Abhandlungen*
Ordovician	United Kingdom	Whitehouse Fm	Neritic, deltaic	Flute casts	Rare		Hubert, 1966, *Journal of Sedimentary Petrology*
Ordovician-Silurian	China	not specified (Kalpingtag Group)	Lower shoreface, offshore, above SWB	Tool marks, gutter casts	Common (gutter casts)		Liu and Zhang, 2008, *Proceedings of the 2008 International Workshop on Education Technology and Training and 2008 International Workshop on Geoscience and Remote Sensing*
Silurian	Libya	Akakus Formation	Shallow marine	Gutter casts	Present		Gindre et al., 2012, *Journal of African Earth Sciences*
Silurian	USA	Clinch Formation	Storm-dominated shoreface	Pot casts, tool marks	Rare		Tarhan et al., 2015, *Nature Geoscience*
Silurian	Canada	Burtts Corner Beds (Kingsclear Group)	Continental rise	Flute casts, tool marks	Present		Whitehead, 2001, *NEIGC Field Guide*
Silurian	United Kingdom	Coniston Grits	Shallow marine	Flute casts, groove marks, sole marks	Common		Prentice, 1960, *The Journal of Geology*
Silurian	USA	Estill Shale	Open marine outer ramp	Skip marks, prod marks, gutter casts, flutes	Common		McLaughlin et al., 2008, *GSA Field Guide*
Silurian	United Kingdom	Gray Sandstone	Shelf, between FWWB and SWB	Gutters, prod marks, groove marks, tool marks	Rare		Hillier and Morrissey, 2010, *Geological Journal*
Silurian	Canada	Gun River Formation	Slightly below SWB	Gutter casts	Common		Zhang et al., 2002, *Canadian Journal of Earth Sciences* ; Long, 2007, *Canadian Journal of Earth Sciences* ; Li and Allen, 2008, *Canadian Journal of Earth Sciences*
Silurian	USA	Herkimer Formation	Shelf, between FWWB and SWB	Tool marks	Common to abundant		Tarhan et al., 2012, *Lethaia* ; Tarhan et al., 2015, *Nature Geoscience*
Silurian	Norway	Holmestrand Formation	Beach, above FWWB	Tool marks	Present		Dam and Andreasen, 1990, *Sedimentary Geology*
Silurian	United Kingdom	Hughley Shales	Distal shelf	Tool marks (groove marks, prod marks, bounce marks, pluck marks, in-out groove marks, prod-rotation marks)	Abundant		Benton and Gray, 1981, *Journal of the Geological Society*
Silurian	Canada	Jupiter Formation	Storm-dominated mid- to outer ramp	Sole marks (gutter casts)	Common		Clayer, 2012, University of Ottawa MSc thesis; Clayer and Desrochers, 2014, *Estonian Journal of Earth Sciences*
Silurian	China	Kepingtage Formation	Storm-dominated shallow marine	Gutter casts	Present		Zhao et al., 2016, *Arabian Journal of Geosciences*
Silurian	Argentina	Los Espejos Formation	Storm-dominated shelf, platform	Flute marks, tool marks, gutter casts, scour marks	Rare		Sanchez et al., 1991, *Journal of South American Earth Sciences* ; Carrera et al., 2013, *Geological Journal*
Silurian	Guinea, Guinea-Bissau	Lower Formation	Shallow marine, epicontinental	Groove casts, tool marks	Present		Villeneuve and Komara, 1991, *Journal of African Earth Sciences*
Silurian	USA	Mifflintown Formation	Storm-dominated ramp	Pot casts	Rare		Tarhan et al., 2015, *Nature Geoscience*
Silurian	United Kingdom	not specified (Coralliferous Group)	Shallow marine	Sole marks, tool marks, prod marks, bounce marks	Present		Hillier, 2002, *Geological Journal*
Silurian	Poland	not specified (Eastern European Platform)	Outer shelf	"Steep-sided scours similar to gutter casts"	Present		Porebski et al., 2013, *Przegląd Geologiczny*
Silurian	USA	Red Mountain Formation	Storm-dominated shelf	Tool marks, groove casts	Present to common		Chowns and Rindsberg, 2015, *GSA Field Guide* ; Tarhan et al., 2015, *Nature Geoscience*
Silurian	USA	Rockwood Formation	Storm-dominated mid- to outer shelf	Pot casts, gutter casts, tool marks	Common		Tarhan et al., 2015, *Nature Geoscience*
Silurian	China	S1zh	Deltaic	Flute casts	Present		Yao and Li, 2016, *Tectonophysics*
Silurian	China	S2+3+4zh	Deltaic	Flute casts	Present		Yao and Li, 2016, *Tectonophysics*
Silurian	Norway	Saelabonn Formation	Storm-dominated shelf	Gutter casts	Present		Garten, 2012, University of Oslo M.S. thesis
Silurian	Libya	Tanezzuft Formation	Shallow marine	Gutter casts	Present		Gindre et al., 2012, *Journal of African Earth Sciences* ; Le Heron et al., 2013, *Journal of the Geological Society, London*
Silurian	USA	Tymochtee Formation	Intertidal	Flute casts	Rare		Kahle and Floyd, 1971, *Geological Society of America Bulletin*
Silurian	USA	Wills Creek Formation	Storm-dominated shelf	Gutter casts	Present		Haynes et al., 2014, *GSA Field Guide*
Silurian	United Kingdom	Wych Beds	Shelf	Gutter casts, tool marks (grooves, prod casts)	Present	Gutters 20 cm wide, 7-9 cm deep; tools <1 cm long	Bridges, 1972, *Geological Magazine*
Silurian-Devonian	Argentina	Río Seco de los Castaños Formation	Storm-dominated or turbiditic proximal platform	Flute marks	Rare		Manassero et al., 2009, *Geological Society, London, Special Publication*
Devonian	Canada	Battery Point Formation	Fluvial-influenced channel bar, tidal sand bar	Flute marks, tool marks, gutter casts, current crescent scours	Present		Griffing et al., 2000, *Geological Society, London, Special Publication*
Devonian	USA	Canadaway Formation	Shallow marine	Groove casts, prod casts, flute casts	Present		Copeland and Straffin, 2011, *NE-NC GSA Abstracts with Programs*
Devonian	USA	Caneadea Formation	Storm-dominated nearshore, offshore	Grooves, flute casts, gutter casts	Common		Smith and Jacobi, 2001, *AAPG Bulletin*
Devonian	USA	Catskill Formation	Deltaic	Flute casts, groove casts	Abundant		Leeper, 1963, *Pennsylvanian Geological Survey Series*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Devonian	Canada	Compton Formation	Prodelta, deep shelf	Flute casts	Present		Lavoie, 2004, *Canadian Journal of Earth Sciences*
Devonian	Canada	Escuminac Formation	Estuarine, brackish	Flute marks/casts, groove casts, brush casts, prod casts	Abundant		Bourque et al., 2001, *Bulletin of Canadian Petroleum Geology* ; Wilson et al., 2005, *Journal of Paleontology*
Devonian	USA	Foreknobs Formation	Storm-influenced shoreface, proximal offshore, FWWB	Flute casts, gutter casts	Rare		McClung et al., 2013, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Devonian	USA	Formation A	Shallow marine	Groove casts	Present		Woodrow, 1963, *Pennsylvanian Geological Survey Series*
Devonian	USA	Gilboa Formation	Shallow marine	Flute marks, tool marks	Present		Bridge and Willis, 1994, *Geological Society of America Bulletin*
Devonian	USA	Grimes Sandstone	Storm-dominated shallow marine	Prod marks, tool marks, pot casts, flutes, grooves	Common		Craft and Bridge, 1987, *Geological Society of America Bulletin*
Devonian	USA	Hanover Formation	Storm-mediated or turbiditic shelf	Gutter casts	Common		Smith and Jacobi, 2001, *AAPG Bulletin*
Devonian	USA	Hatch Formation	Storm-dominated shallow marine	Flute marks, prods, tools	Present	Flutes dm- to m-scale length, cm-scale width	Craft and Bridge, 1987, *Geological Society of America Bulletin*
Devonian	USA	Ithaca Shale Formation	Storm-dominated shelf	Flute casts, gutter casts	Present		Brennan et al., 2005, *Geological Society of America Abstracts with Programs*
Devonian	United Kingdom	Jacket's Point Slate Formation	Shelf margin	Gutter casts	Common		Selwood and Thomas, 1986, *Journal of the Geological Society, London*
Devonian	USA	Jennings Formation (Chemung Formation)	Shallow marine, slope	Flute casts, groove casts	Rare		Leeper, 1963, *Pennsylvanian Geological Survey Series*
Devonian	USA	Mahantango Formation	Tide- and storm-dominated shallow marine foreland basin	Sole marks	Rare to common		Prave et al.,1996, *Sedimentology*
Devonian	Australia	Mt. Ida Sandstone (Eildon Sandstone)	Shallow marine	Flute marks, groove marks	Present		Powell et al., 2003, *Tectonophysics*
Devonian	Germany	Nellenköpfchen Formation	Shallow marine to brackish, intertidal, emergent	Flute casts	Present		Wehrmann et al., 2005, Palaios
Devonian	China	Niuerchuan Formation	Shelf margin and tidal flats	Sole marks	Present		Yan et al., 2006, *International Geology Review*
Devonian	Australia	not specified (Walhalla Group)	Storm-dominated shelf	Flute marks, groove marks, gutter marks	Common		Dyson, 1996, *Australian Journal of Earth Sciences*
Devonian	USA	Ohio Shale	Storm-dominated, sub-SWB shallow marine	Flute casts, groove casts, prod casts, sole marks	Rare (flutes and prods) to common and abundant (grooves)		Lewis, 1998, *Ohio Journal of Science* ; Alshahrani, 2013, Bowling Green State University M.S. thesis
Devonian	Argentina	Punta Negra Formation	Prodelta, shelf (previously interpreted as submarine fan)	Flute casts, frondescent casts, sole marks, tool marks, grooves, prod casts, furrow casts, gutter casts	Rare to abundant (tools, grooves and prods)		Gonzalez-Bonorino and Middleton, 1976, *Journal of Sedimentary Petrology* ; Basilici et al., 2012, *Sedimentary Geology*
Devonian	Australia	Roxburgh Formation	Nearshore to outer shelf	Flute marks, sole marks, tool marks	Common (groove and tool marks)		Colquhoun, 1995, *Sedimentary Geology*
Devonian	United Kingdom	Saltash Formation (Trevose Slate Formation, Nordon Formation)	Shallow marine	Gutter casts	Present		Leveridge and Hartley, 2006, in *The Geology of England and Wales*
Devonian	Brazil	Sao Domingos Formation	Shallow marine	Tool marks (roll marks), groove marks	Present		Horodyski et al., 2014, *International Journal of Earth Sciences*
Devonian	USA	Scherr Formation	Shoreface	Flute casts, tool marks	Present		Van Tassell, 1987, *Geological Society of America Bulletin*
Devonian	USA	Triangle Formation	Shallow marine	Grooves, gutter casts	Present		Sutton et al., 1970, *Geological Society of America Bulletin* ; Schieber, 1999, J*ournal of Sedimentary Research* ; Lazar et al., 2015, *SEPM Concepts in Sedimentology and Paleontology*
Devonian	China	Yangmaba Formation	Storm-mediated shallow marine	Gutter casts, putative groove casts	Present		Zhang, 2014, *Geological Journal* ; Li et al., 2017, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Carboniferous	Canada	Albert Formation	Wave-dominated delta-front, brackish embayment	Flute casts, tool marks	Rare		Falcon-Lang, 2004, *Journal of the Geological Society, London*
Carboniferous	United Kingdom	Ashover Grit	Delta slope	Flutes, tool marks	Present		Chisholm and Waters, 2012, *Proceedings of the Yorkshore Geological Society*
Carboniferous	USA	Crab Orchard Mountain Formation	Tidal flat	Tool marks	Present		Schneck and Fritz, 1985, *Journal of Paleontology*
Carboniferous	USA	Cuyahoga Formation	Sub-WB shallow marine	Sole markings, tool marks	Present		Richards, 1974, *The Ohio Journal of Science*
Carboniferous	South Africa	Floriskraal Formation	Storm-dominated shallow marine	Gutter casts	Rare		Browning and Penn-Clarke, 2016, *South African Journal of Geology*
Carboniferous	USA	Grainger Formation	Deltaic	Groove casts, tool marks	Rare to present to abundant		Robertson, 2014, Purdue University M.S. thesis
Carboniferous	USA	Holder Formation	Inner shelf	Flute casts, groove casts, sole marks, tool marks	Common		Carr and Scott, 1990, *Journal of Sedimentary Petrology*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Carboniferous	Canada	Horton Bluff Formation	Intertidal to shallow marine	Kullingia (scratch circles) [intertidal; Jensen et al., 2002], tool marks, gutter casts, groove casts [shallow marine; Mansky and Lucas, 2013]	Rare (gutter casts) to present		Jensen et al., 2002, *Lethaia* ; Rygel et al., 2006, *GSA Special Paper* ; Mansky and Lucas, 2013, in *The Carboniferous-Permian Transition*
Carboniferous	United Kingdom	Huddersfield White Rock (Chatsworth Grit)	Delta slope	Flute marks, tool marks	Present		Waters et al., 2008, *Proceedings of the Yorkshire Geological Society*
Carboniferous	United Kingdom	Instow Beds	Shallow marine	Flute casts, groove marks, sole marks	Common		Prentice, 1960, *The Journal of Geology*
Carboniferous	Canada	Joggins Formation	Storm- and hyperpycnally influenced, brackish to emergent	Grooves, flutes	Present		Falcon-Lang, 2005, *Journal of the Geological Society, London*
Carboniferous	USA	Kanwaka Shale	Intertidal	Flute casts, tool marks, gutter casts, pot casts	Common (gutter and pot casts)		Mangano et al., 1998, *Palaios*
Carboniferous	South Africa	Kweekvlei Formation	Storm-dominated offshore transition zone	Gutter casts	Rare		Browning and Reid, 2017, *South African Journal of Geology*
Carboniferous	Brazil	Longa Formation	Wave-influenced, deltaic	Gutter casts	Present		Playford et al., 2012, *Revista Espagñola de Micropaleontología*
Carboniferous	United Kingdom	Lower Limestone Formation	Prodelta to delta front	Sole marks (flute casts, gutter casts)	Present	Gutter casts deeply incised (e.g. 40 cm deep)	Fielding and Frank, 2015, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Carboniferous	USA	Minturn Formation	Prodelta, hyperpycnally influenced	Sole marks, grooves, prods, chevrons, flutes, gutter casts, tool marks, drag marks	Common to abundant		Lamb et al., 2008, *Journal of Sedimentary Research* ; Myrow et al., 2008, *Journal of Sedimentary Research;* Myrow et al., 2010, *Colorado College Field Guide*
Carboniferous	United Kingdom	Pathhead Formation	Prodelta to delta front, estuarine	Sole marks (flute casts, gutter casts)	Present		Fielding and Frank, 2015, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Carboniferous	USA	Pikeville Formation	Prodelta, delta front	Flute marks, tool marks	Present		Jerrett et al., 2016, *Geological Society of America Bulletin*
Carboniferous	USA	Pottsville Formation	Tidal flat, estuarine, brackish	Tool marks	Present		Demko and Gastaldo, 1996, *International Journal of Coal Geology*
Carboniferous	USA	Price Formation	Nearshore to outer shelf	Flute marks, tool marks, gutter casts, Kullingia (scratch circles)	Present		Murphy, 2001, West Virginia University M.S. thesis; Jensen et al., 2002, *Lethaia*
Carboniferous	USA	Pride Mountain Formation	Beach/shoreface	Kullingia (scratch circles)	Present		Jensen et al., 2002, *Lethaia*
Carboniferous	China	Qijiagou Formation	Shallow marine	Flute casts	Rare		Carroll et al., 1995, *Geological Society of America Bulletin*
Carboniferous	United Kingdom	Sandy Craig Formation	Shallow marine, estuarine	Gutter casts	Present		Fielding and Frank, 2015, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Carboniferous	USA	Stranger Formation	Fluvio-estuarine, tidal flat	Tool marks, stick marks, drag marks, prod marks, groove marks	Present		Lanier et al., 1993, *Journal of Sedimentary Petrology* ; Buatois et al., 1997, *Palaios* ; Buatois et al., 1998, *Journal of Paleontology* ; Mangano and Buatois, 2004, *Geological Society, London, Special Publication*
Carboniferous	Morocco	Unit 4	Outer shelf to upper slope	Grooves	Present		Graham, 1982, *Sedimentary Geology*
Carboniferous	Morocco	Unit 5	Shelf	Tool marks, flute marks, grooves	Present		Graham, 1982, *Sedimentary Geology*
Carboniferous	Morocco	Unit 6	Shelf	Tool marks	Present		Graham, 1982, *Sedimentary Geology*
Carboniferous	USA	Wann Formation	Shallow marine, likely emergent	Flute casts, tool marks	Present		Scott, 2015, *SC Geological Society of America Abstracts with Programs*
Carboniferous-Permian	South Africa	not specified (Dwyka Group)	Shallow marine, glaciomarine	Grooves	Present to common		Blignault and Theron, 2012, *South African Journal of Geology*
Carboniferous-Permian	Russia	not specified (Konduovka and Novogafarovo sections)	Storm-dominated middle-outer ramp	Flute marks, tool marks (SS3), flute marks (WPGe)	Rare		Schiappa and Snyder, 1998, *Permophiles*
Carboniferous-Permian	India	Talchir Formation	Shallow marine, glaciomarine	Sole marks (gutter casts, flute casts, groove marks, prod marks, bounce marks)	Present		Bhattacharya et al., 2004, *Sedimentary Geology* ; Bhattacharya et al., 2007, *Journal of the Geological Society of India* ; Bhattacharya and Bhattacharya, 2011, I*ndian Journal of Geosciences* ; Bhattacharya and Bhattacharya, 2015, *Journal of Palaeogeography*
Permian	United Kingdom	Brotherton Formation	Storm-dominated platform, shelf	Gutter casts	Present to common		McKie, 1994, *Sedimentary Geology*
Permian	USA	Robledo Mountains Formation	Tidal flat	Pot casts, scratch circles	Common (pot casts)		Lerner and Lucas, 2015, in *Carboniferous-Permian Transition in the Robledo Mountains, Southern New Mexico*
Permian	South Africa	Waterford Formation	Shallow marine (shelf and upper slope)	Flute casts, groove marks	Present		Poyatos-Moré et al., 2016, *Journal of Sedimentary Research*
Permian-Triassic	Greenland	Wordie Creek Formation	Shallow marine	Gutter casts	Present		Twitchett et al., 2001, *Geology*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Triassic	USA	Unit C (Thaynes Group)	Lower shoreface to offshore, mid- to outer ramp	Gutter casts	Present		Hofmann et al., 2013, *Acta Palaeontologica Polonica* ; Vennin et al., 2015, Sedimentology
Triassic	USA	Andorno Formation	Shallow marine	Flute casts	Common		Compton, 1960, *Geological Society of America Bulletin*
Triassic	China	Baifeng Formation	Storm-dominated shallow marine	Gutter casts, "flute imprints"	Present		Wang et al., 2017, *Sedimentary Geology*
Triassic	Spain	Cehegin Formation (Majanillos Formation)	Nearshore bypass zone, ramp	Pot casts, gutter casts (with coarse and bioclastic infill)	Present		Perez-Lopez, 2001, *Sedimentology* ; Perez-Lopez and Perez-Valera, 2012, *Sedimentology*
Triassic	Denmark	Gassum Formation	Lower shoreface, sub-FWWB	Gutter casts	Common		Hamberg and Nielsen, 2000, *Geological Society, London, Special Publication*
Triassic	USA	Ivishak Formation	Shelf	Tool marks	Present		Harun, 1987, *Alaska Division of Mining and Geological and Geophysical Surveys*
Triassic	Germany	Jena Formation	Tidal flat	Gutter casts	Present		Knaust, 2013, *Earth-Science Reviews*
Triassic	Australia	Kockatea Shale Formation	Shallow marine	Tool marks	Common		Chen et al., 2012, *Gondwana Research*
Triassic	Germany, United Kingdom	Lower Keuper Formation	Storm-dominated, proximal to intermediate shelf, brackish nearshore	Tool marks, gutter casts (Germany); flute casts, groove casts, ctenoid casts (essentially bounce marks) (United Kingdom)	Rare (flutes, ctenoid casts) to common (gutters, grooves)		Cummins, 1961, *Geological Journal* ; Pöppelreiter and Aigner, 2003, *AAPG Bulletin*
Triassic	Germany	Meissner Formation	Shallow marine	Flute casts, pot casts	Present		Knaust, 2013, *Earth-Science Reviews*
Triassic	USA	Moenkopi Formation	Tidal flat, deltaic, brackish embayment	Sole marks, tool marks, flute marks, current crescents, gutter casts	Present		Reif and Slatt, 1979, *Journal of Sedimentary Petrology* ; Blakey, 1989, *Arizona Geological Society Digest* ; Twitchett et al., 2005, *Palaios* ; Thomson, 2014, UC Riverside M.S. Thesis
Triassic	Canada	Montney Formation	Offshore-shoreface transition zone, sub-FWWB, dysoxic	Flute marks, tool marks (groove marks and brush marks)	Present to common (tools)		Zonneveld et al., 2010, *Bulletin of Canadian Petroleum Geology* ; Zonneveld et al., 2010, *Palaios*
Triassic	Germany, Netherlands	Muschelkalk Formation	Storm-reworked, lagoonal, intertidal, emergent	Pot casts, gutter casts, tool marks	Present to common		Knaust and Langbein, 1995, *Facies* ; Knaust, 2002, *Journal of Paleontology* ; Borkhataria et al., 2006, *AAPG Bulletin* ; Knaust, 2007, *SEPM Special Publication*
Triassic	Iran	Nayband Formation	Storm-influenced mid-ramp	Flute casts	Present		Fürsich et al., 2007, *Palaios*
Triassic	Turkey	not specified (Bolkar nappe)	Nearshore	prod/groove marks	Present		Mackintosh and Robertson, 2012, *Gondwana Research*
Triassic	Spain	Pont de Suert Formation	Intertidal	Kullingia/Scharrkreise (scratch circles)	Present		Dixon, 1987, *Proceedings of the Geologists' Association* ; Jensen et al., 2002, *Lethaia*
Triassic	USA	Red Peak Formation	Shallow marine	Flute marks, tool marks	Rare		Picard and High, 1968, *Journal of Sedimentary Petrology*
Triassic	Canada	Toad Formation	Storm-influenced, between FWWB and sub-SWB	Tool marks, flute casts, pot casts, gutter casts	Rare to common		MacNaughton, 2002, *Geological Survey of Canada, Current Research* ; Utting et al., 2005, *Bulletin of Canadian Petroleum Geology*
Triassic	Spain	Tramacastilla Dolostones Formation (Siles Formation)	Offshore transition zone	Gutter marks/casts, pot casts	Present		Rodriguez-Tovar and Perez-Valera, 2008, *Palaios* ; Perez-Lopez and Perez-Valera, 2012, *Sedimentology* ; Sanchez-Moya et al., 2016, *Journal of Iberian Geology*
Triassic	Norway	Vardebukta Formation	Storm-mediated, hyperpycnally influenced shoreface; dysoxic	Flute marks	Rare		Wignall et al., 2016, *Geological Magazine*
Triassic	USA	Virgin Formation	Storm-dominated lower shoreface to offshore	Gutter casts	Present		Hofmann et al., 2013, *Acta Palaeontologica Polonica*
Triassic	Italy	Werfen Formation	Ramp	Gutter casts, multidirectional tool marks	Present		Wignall and Twitchett, 1999, *Sedimentology* ; Twitchett et al., 2005, *Palaios* ; Baucon and Neto de Carvalho, 2016, *Palaios*
Triassic	United Kingdom	Westbury Formation	Shallow marine	Gutter casts, groove marks, tool marks	Locally abundant (grooves and tools)	Sub-mm-scale width, mm-scale length	Wright and Benton, 1987, *Palaeontology* ; Radley, 2011, *Geoscience in South-West England*
Jurassic	United Kingdom	Blue Lias Formation	Storm-dominated shallow marine, sub-SWB	Gutter casts	Present		Radley, 2008, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Jurassic	USA	Carmel Formation	Marginal marine, tidal flat, lacustrine influence	Sole marks, tool marks	Present		Blakey, 1989, in *Geologic Evolution of Arizona*
Jurassic	India	Chari Formation	Shallow marine	Flute casts, tool marks	Present		Fürsich and Oschmann, 1993, *Journal of the Geological Society, London* ; Fürsich et al., 2004, *Rivista Italian di Paleontologica e Stratigrafia*

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Jurassic	United Kingdom	Cleveland Ironstone Formation	Storm-dominated shelf	Gutter casts, groove casts	Common (gutter casts)	Gutters up to 5 m long, 5-50 cm diameter, up to 20 cm relief	Greensmith et al., 1980, *Proceedings of the Yorkshire Geological Society* ; Hallam, 1997, *Journal of the Geological Society, London* ; Powell, 2010, *Proceedings of the Yorkshire Geological Society* ; Aplin and Macquaker, 2011, *AAPG Bulletin* ; Ghadeer and Macquaker, 2011, *Journal of the Geological Society, London* ; Bohacs et al., 2014, *Geology*
Jurassic	Iran	Dalichai Formation	Lower shelf	Flute casts, groove casts	Present		Fürsich et al., 2007, *Palaios*
Jurassic	Uzbekistan	Degibadam Formation	Storm-influenced outer ramp	Flute casts, tool marks, gutter casts	Common		Fürsich et al., 2017, *Geological Society, London, Special Publications*
Jurassic	Canada	Fernie Formation	Shelf	Flute marks, tool marks (plant-mediated drag, prod, skip marks), fluted burrow marks	Abundant		Chough et al., 1998, *Geoscience Journal*
Jurassic	USA	Formation A	Shallow marine	Flute casts, groove casts	Rare		Ojakangas, 1968, *Geological Society of America Bulletin*
Jurassic	India	Jhuran Formation (Katrol Formation)	Storm-influenced shallow marine	Tool marks, gutter casts, flute casts, sole marks, prod marks, groove casts, skip marks	Common to abundant (with exception of flute casts)	Average gutter cast size: 16 cm long, 5 cm deep	Arora et al., 2015, *Journal of the Geological Society of India*
Jurassic	Iran	Kashafrud Formation	Storm-influenced, turbidite-influenced sub-SWB shallow marine	Flute casts, groove casts	Present		Fürsich et al., 2007, *Palaios*
Jurassic	United Kingdom	Kimmeridge Clay	Deep shelf, dysoxic	Gutter casts	Rare		Wignall, 1989, *Journal of the Geological Society, London*
Jurassic	Pakistan	Loralai Formation	Shallow marine	Flute casts, sole marks	Present		Durrani et al., 2012, *Journal of Himalayan Earth Sciences*
Jurassic	Russia	Mount Indyuk Formation	Shelf, between FWWB and SWB	Grooves, flute marks	Present		McCannn et al., 2010, *Geological Society, London, Special Publication*
Jurassic	Switzerland	Opalinuston Formation	Storm-influenced, ~SWB, epicontinental	Pot casts	Present		Wetzel and Meyer, 2006, *Palaios*
Jurassic	United Kingdom	Redcar Mudstone Formation	Shallow marine	Gutter casts	Present		Powell, 2010, *Proceedings of the Yorkshire Geological Society*
Jurassic	Iran	Shemshak Formation	Storm-influenced prodelta to delta front, sub-SWB	Flute casts, groove casts	Present		Fürsich et al., 2007, *Palaios*
Jurassic	Germany	Solnhofen Formation	Lagoonal, tidal	Tool marks, roll marks	Present		Adler and Roper, 2012, *Neues Jahrbuch für Geologie und Paläontologie-Abhandlungen*
Jurassic	United Kingdom	Staithes Sandstone Formation	Offshore, shelf, sub-FWWB	Gutter casts	Present		Powell, 2010, *Proceedings of the Yorkshire Geological Society*
Jurassic	USA	Summerville Formation	Restricted marine	Sole marks, tool marks	Present		Blakey, 1989, in *Geologic Evolution of Arizona*
Jurassic	USA	Sundance Formation	Storm-mediated mid-ramp	Putative prod marks	Present		Michalak, 2013, Dartmouth College M.S. thesis
Jurassic	Morocco	Tazigzaout Formation	Offshore shelf	Flute casts, furrows, striations, grooves	Present		Ait Addi, 2008, *Volumina Jurassica*
Jurassic	United Kingdom	White Limestone	Tidal flat	Groove casts, prod marks, bounce casts	Common (prod marks, bounce casts)		Klein, 1965, *SEPM Special Publication*
Jurassic-Cretaceous	Tibet	Gucuo Formation	Shelf, above SWB	Flute casts	Present		Hu et al., 2008, *Cretaceous Research*
Jurassic-Cretaceous	Mozambique	Pemba Formation	Marginal to shallow marine, fluviodeltaic, emergent	Flute casts	Present		Key et al., 2008, *South African Journal of Geology*
Cretaceous	Argentina	Agrio Formation	Storm-influenced mid-ramp	Flute casts	Rare to present		Lazo et al., 2005, *Geological Society, London Special Publication*
Cretaceous	Chile	Apeleg Formation	Outer shelf, sub-WB	Kullingia (scratch circles)	Present		Jensen et al., 2002, *Lethaia*
Cretaceous	Canada	Bearpaw Formation	Shallow marine	Gutter casts	Present		Hathway, 2016, *Bulletin of Canadian Petroleum Geology*
Cretaceous	Germany	Bentheim Sandstone Formation	Deltaic	Gutter casts, groove casts	Present	Large gutter casts	Wonham et al., 1997, *GCSSEPM Special Publication*
Cretaceous	India	Bhuj Formation	Storm-influenced outer shelf	Groove casts	Present		Mandal et al., 2016, *Marine and Petroleum Geology*
Cretaceous	USA	Blackhawk Formation	Shoreface to shelf, offshore transition zone, deltaic	Flute casts, groove casts, prod marks, sole marks, gutter casts	Present	Large gutter casts, up to 3 m wide, 1 m deep (commonly 50 cm deep)	Swift et al., 1987, *Sedimentology* ; Hampson, 2000, *Journal of Sedimentary Research* ; Taylor et al., 2002, *Journal of Sedimentary Research* ; Pattison, 2005, *GSA Field Guide* ; Pattison and Davies, 2007, *GSA Field Guide* ; Hampson et al., 2008, *SEPM Special Publication* ; Graham, 2014, Imperial College London PhD Dissertation; Eide et al., 2015, *Petroleum Geoscience*
Cretaceous	Canada	Blackstone Formation	Inner shelf	Gutter casts	Rare		Leckie et al., 2000, *Geological Society of America Bulletin* ; Plint and Cheadle, 2015, *Sedimentology*
Cretaceous	Morocco	Bouzergoun Formation	Shelf, sub-SWB	Groove marks, tool marks	Present		Nouidar and Chellai, 2002, *Sedimentary Geology*

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Geologic Period	Geography	Geologic Unit	Paleoenvironment	Sole Mark Type	Sole Mark Density	Sole Mark Size	Reference (Author, Year, Journal)
Cretaceous	USA	Bridge Creek Limestone (Dakota Formation, Tropic Formation)	Storm-dominated shoreface	Gutter casts	Present		Laurin and Sageman, 2007, *Journal of Sedimentary Research*
Cretaceous	Canada	Cardium Formation	Shoreface transition zone to offshore	Gutter casts, groove casts	Present (groove casts) to abundant (gutter casts)	"Large-scale" gutter casts	Deutsch, 1992, University of Calgary MSc thesis; Hart and Plint, 2003, *Bulletin of Canadian Petroleum Geology*
Cretaceous	USA	Cliff House Sandstone	Proximal lower shoreface to offshore, sub-SWB	Gutter casts	Present to locally abundant		Jordan et al., 2016, *Journal of Sedimentary Research*
Cretaceous	USA	Del Rio Formation	Storm-influenced shallow marine, brackish	Prod, groove and tool marks, skip marks, gutter casts	Common		Lock and Bases, 2008, *AAPG Annual Meeting* ; Lock et al., 2009, *Gulf Coast Association of Geological Societies Transactions*
Cretaceous	USA	Denton Formation	Shallow marine	Tool marks (grooves)	Abundant		Scott et al., 1975, *Journal of Sedimentary Petrology*
Cretaceous	Chile	Dorotea Formation	Shelf, deltaic	Sole marks, tool marks	Rare		Covault et al., 2009, *Journal of Sedimentary Research*
Cretaceous	Canada	Dunvegan Formation	Prodelta	Gutter casts	Rare		Plint and Nummedal, 2000, *Geological Society, London, Special Publication* ; Bhattacharya and MacEachern, 2009, *Journal of Sedimentary Research* ; Coates and MacEachern, 2009, *Applied Ichnology* ; Hay and Plint, 2009, *Bulletin of Canadian Petroleum Geology* ; Plint et al., 2009, *Journal of Sedimentary Research* ; Plint, 2014, *Sedimentology* ; Plint and Cheadle, 2015, *Sedimentology*
Cretaceous	USA	Eagle Ford Formation	Storm-influenced shallow marine	Gutter casts	Present		Bohacs et al., 2014, *Geology*
Cretaceous	USA	Eagle Formation (Rock Springs Formation)	Lower shoreface, inner shelf, deltaic	Flute marks, groove marks, gutter casts	Present (flutes marks, groove marks) to abundant (gutter casts)		Fitzsimmons and Johnson, 2000, *Geological Society, London, Special Publication* ; Plink-Björklund, 2008, *SEPM Special Publication* ; Swift et al., 2008, *SEPM Special Publication*
Cretaceous	Spain	Escucha Formation	Storm-influenced, above WB	Gutter casts, groove casts, bounce casts, flute casts, scour casts, sole casts	Common		Rodríguez-López et al., 2007 *Sedimentary Geology*
Cretaceous	Spain	Fardes Formation	Upper slope	Sole marks	Present		Reicherter et al., 1994, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Cretaceous	USA	Fox Hills Sandstone	Delta front	Gutter casts	Rare		Carvajal and Steel, 2009, *Journal of Sedimentary Research*
Cretaceous	USA	Frontier Formation	Prodelta, delta front, coastal plain	Gutter casts, sole marks, tool marks	Present	Gutter casts range from ~5 cm deep, to 1.5 m deep	Gani and Bhattacharya, 2007, *Journal of Sedimentary Research* ; Hutsky and Fielding, 2017, *Sedimentology*
Cretaceous	Chile	Fuentes Formation	Shelf	Tool marks	Present		Macdonald, 1986, *Revista Geológica de Chile*
Cretaceous	USA	Greenhorn Limestone	~SWB	Flute marks, tool marks	Common		Sageman, 1996, *Geology*
Cretaceous	USA	Haystack Mountains Formation	Lower shoreface, inner shelf	Flute casts, groove casts, gutter casts	Rare	Gutters can be 30-80 cm thick	Mellere and Steel, 2000, *Geological Society, London, Special Publication*
Cretaceous	Argentina	Huitrín Formation	Lower shoreface to offshore transition zone	Gutter casts	Rare	Gutters up to 40 cm deep and 20 cm wide	Veiga et al., 2005, *Geological Society, London, Special Publication*
Cretaceous	Canada	Kaskapau Formation	Shallow marine bypass zone	Gutter casts	Rare	Cm-scale gutter casts	Plint, 2000, *Bulletin of Canadian Petroleum Geology* ; Varban and Plint, 2005, *Bulletin of Canadian Petroleum Geology* ; Kreitner and Plint, 2006, *Bulletin of Canadian Petroleum Geology* ; Plint and Kreitner, 2007, *Geology* ; Plint et al., 2012, *Journal of Sedimentary Research*
Cretaceous	USA	Kiamchi Formation	Shallow marine	Tool marks (grooves)	Abundant		Scott et al., 1975, *Journal of Sedimentary Petrology*
Cretaceous	USA	Mancos Shale (Castlegate Sandstone, Point Lookout Sandstone, Iles Formation)	Shoreface, foreshore, barrier island, inner shelf, deltaic, lagoonal (restricted)	Gutter casts, helical sole marks on gutter cast bases, tool marks, bounce marks, prod marks, drag marks	Present to rare	Large gutter casts (m-scale length, dm-scale depth)	Chan, 1992, *Journal of Sedimentary Petrology* ; Pattison, 2005, *Journal of Sedimentary Research* ; Bullimore et al., 2008, *SEPM Special Publication* ; Sixsmith et al., 2008, *AAPG Bulletin* ; York et al., 2011, *Journal of Sedimentary Research* ; Painter et al., 2013, *Journal of Sedimentary Research* ; Legler et al., 2014, *Journal of Sedimentary Research* ; Andresen, 2015, Colorado School of Mines M.S. thesis; Fielding, 2015, *Sedimentology* ; Gomez-Veroiza and Steel, 2017, *Interpretation* ; Korus and Fielding, 2017, *Journal of Sedimentary Research*
Cretaceous	Canada	Marshybank Formation	Shoreface to inner shelf	Gutter casts	Present to locally abundant		Plint and Nummedal, 2000, *Geological Society, London, Special Publication*
Cretaceous	USA	Masuk Formation	Lagoonal, estuarine, tidal, brackish	Tool marks, gutter casts	Present		Corbett et al., 2011, *Journal of Sedimentary Research*
Cretaceous	Canada	Missisauga Formation	Prodelta to delta front	Groove cast	Present		Gould et al., 2010, *Sedimentology*

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Cretaceous	Argentina	Mulichinco Formation	Shoreface, shelf, deltaic	Flute marks, gutter casts	Present (gutter casts) to common (flute marks)		Schwarz and Howell, 2005, *Geological Society, London, Special Publication*
Cretaceous	Australia	Mullaman Beds	Shelf	Tool marks, gutter casts	Rare (gutter casts) to present	Gutter casts up 0.8 m long, 40 cm wide	Krassay, 1994, *Sedimentary Geology*
Cretaceous	Oman	Muti Formation	Shelf, bank, shoal	Putative "tool mark-like structures"	Present		Phillips et al., 2012, *Lithosphere Dynamics and Sedimentary Basins: The Arabian Plate and Analogues*
Cretaceous	France	not specified (Urgonian)	Platform	Sole marks (gutter casts)	Present		Leonide et al., 2012, *Sedimentary Geology*
Cretaceous	Pakistan	Pab Formation	Storm-dominated mid- to outer shelf	Groove marks, prod marks, flute casts	locally common (flute casts)		Khan et al., 2002, *Journal of Petroleum Geology*
Cretaceous	USA	Pawpaw Formation	Shallow marine	Tool marks (grooves), flute casts	Rare (flute casts) to abundant (tool marks)		Scott et al., 1975, *Journal of Sedimentary Petrology*
Cretaceous	Canada	Peace River Formation	Storm-influenced offshore shallow marine	Gutter casts	Present	Gutter casts cm-scale	Buckley et al., 2016, *Sedimentology*
Cretaceous	Brazil	São Sebastião Formation	Deltaic, brackish	Sole marks (flute casts, groove casts)	Present		Murphy and Schlanger, 1962, *AAPG Bulletin*
Cretaceous	Canada	Shaftesbury Formation	Shallow marine	Gutter casts	Rare		Plint and Cheadle, 2015, *Sedimentology*
Cretaceous	USA	Skull Creek Formation	Storm-influenced shoreface to offshore	Gutter casts	Present		Graham and Etheridge, 1995, *Mountain Geologist* ; Graham, 2000, *AAPG Bulletin* ; Sutton et al., 2004, *AAPG Bulletin* ; Masterson, 2015, Colorado State University M.S. Thesis
Cretaceous	Germany	Söhlde Formation	Shelf	Gutter casts	Present		Wiese, 2009, *SEPM Special Publication*
Cretaceous	Canada	Spirit River Formation	Shoreface, strandplain, emergent	Flute casts	Present		Caddel and Moslow, 2004, *Bulletin of Canadian Petroleum Geology*
Cretaceous	USA	Star Point Formation	Deltaic	Flute casts, tool marks	Present (flute casts) to common (tool marks)		Olariu et al., 2010, *AAPG Bulletin* ; Kamola and Louni, 2011, *GSA Abstracts with Programs* ; Forzoni et al., 2015, *Journal of Sedimentary Research*
Cretaceous	USA	Tingmerkpuk Sandstone	Outer shelf to upper slope, above SWB	Groove casts	Common		Lepain et al., 1999, *Alaska Geological Society Science and Technology Conference*
Cretaceous	England	Vectis Formation	Lagoonal, emergent	Groove casts, tool marks, gutter casts	Rare		Radley et al., 1998, *Cretaceous Research* ; Radley and Barker, 2000, *Geological Magazine* ; Sweetman, 2015, *SVPCA Field Guide*
Cretaceous	Canada	Viking Formation	Delta front	Gutter casts	Present		Dafoe and Pemberton, 2009, in *Applied Ichnology*
Cretaceous	Canada, USA	Wapiabi Formation	Storm-dominated shelf, between FWWB and SWB	Gutter casts, sole marks, grooves, prod marks	Common	Gutter casts 5-10 cm wide, a few cm deep	Cheel, 1991, *Journal of Sedimentary Petrology* ; Grifi, 2012, The University of Western Ontario M.S. thesis
Paleogene	Norway	Battfjellet Formation	Upper shoreface	Flute casts	Present		Müller and Spielhagen, 1990, *Palaeogeography, Palaeoclimatology, Palaeoecology*
Paleogene	Egypt	Birket Qarun Formation	Shoreface	Gutter casts	Present		Peters et al., 2009, *Palaios*
Paleogene	Iran	Karaj Formation	Marginal shallow marine to sabkha	Groove casts	Present		Taghipour and Mackizadeh, 2012, *Neues Jahbuch für Geologie und Paläontologie-Abhandlungen*
Paleogene	Colombia	Lisama Formation	Deltaic	Flute casts	Common		Moreno et al., 2011, *Journal of South American Earth Sciences*
Paleogene	Iran	Marich Unit (Konashamir Sandstone)	Shallow marine	Flute casts	Present		McCall, 2002, *Geological Society, London, Special Publication*
Paleogene	Switzerland	Meletta Beds	Shallow marine	Flute casts, groove casts	Present		Kuhlemann et al., 1999, *Neues Jahbuch für Geologie und Paläontologie-Abhandlungen*
Paleogene	India	Miru Formation	Deltaic	Flute casts, gutter casts, tool marks, current crescents	Present		Henderson et al., 2011, *Earth-Science Reviews*
Paleogene	Japan	not specified (Kumage Group)	Deltaic	Flute casts, groove casts, striation casts, gutter casts, furrow-and-ridge casts, prod casts, bounce casts, brush casts, crescentic scour casts	Rare (furrow-and-ridge, prods, bounces, brushes, crescentic scours) to common (flutes, grooves, striations, gutters)		Whitaker, 1982, *Proceedings of the Geologists' Association*
Paleogene	Azerbaijan	not specified (Neslin Suite)	Deltaic	Flute marks, groove marks, prod marks	Present to common		Vincent et al., 2005, *Geological Society of America Bulletin*
Paleogene	Azerbaijan	not specified (Sishnavar Sub-suite, Maykop Suite)	Delta front	Groove marks, prod marks, flute marks	Common (grooves and prods)		Vincent et al., 2005, *Geological Society of America Bulletin*
Paleogene	Jamaica	not specified (Wagwater Belt)	Shelf, platform	Flute casts, sole marks	Present		Mann and Burke, 1984, *Geology*

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Paleogene	Antarctica	Polonez Cove Formation	Deltaic, glaciomarine	Gutter casts	Present		Quaglio et al., 2014, *Antarctic Science*
Paleogene	Croatia	Promina Beds	Upper shoreface	Gutter cast/channel	Present		Babić and Zupaniĉ, 2012, *Geologia Croatica*
Paleogene	India	Subathu Formation	Shoreface to inner shelf, ramp	Gutter cast, flute marks, groove marks	Present		Singh and Srivastava, 2011, *Journal Geological Society of India* ; Bhatia et al., 2013, *Journal of the Palaeontological Society of India*
Paleogene	USA	Tallahatta Formation	Middle shelf, offshore transition zone	Gutter casts	Present		Savrda et al., 2010, *Palaios*
Paleogene	Turkey	Unit 1	Storm-influenced shallow marine	Flutes, grooves, sole marks, tool marks, prod marks	Common		Gökçen and Kelling, 1985, *Geologische Rundschau*
Paleogene	United Kingdom	Wittering Formation	Estuarine, lagoonal, brackish, emergent	Gutter casts	Abundant		Huggett et al., 2005, *Journal of Sedimentary Research*
Paleogene	Turkey	Yenlce Formation	Shallow marine	Flute marks, groove marks	Present		Gürbüz and Gül, 2005, *Turkish Journal of Earth Sciences*
Paleogene-Neogene	India	Lower Murree Formation	Estuarine, tidal flat, emergent	Flute casts, groove casts	Present		Singh and Singh, 1995, in *Tidal Signatures in Modern and Ancient Environments*
Neogene	Austria	Türkenschanze Formation	Marginal epeiric marine, brackish, lacustrine influence	Flute casts, groove casts	Present		Glaessner, 1958, *The Journal of Geology*
Neogene	Iran	Agha Jari Formation	Estuaruine- and fluvial-influenced tidal flat	Flute casts	Present		Pirouz et al., 2016, *Geological Society of America Special Paper*
Neogene	Borneo	Belait Formation (Miri Formation, Lambir Formation)	Storm-influenced shoreface to delta front	Gutter casts (including pot casts)	Common	Gutters 0.1-2 m thick, 0.15-10.8 m wide (average 0.34 m thick, 2 m wide)	Collins et al., 2017, *Sedimentology*
Neogene	Denmark	Billund Sand	Shoreface	Gutter casts	Present		Hansen and Rasmussen, 2008, *Journal of Sedimentary Research*
Neogene	Italy	Botro dell'Acqua Bianca Clays	Lagoonal	Flute casts, groove casts	Rare		Cornamusini et al., 2011, *Italian Journal of Geosciences*
Neogene	Australia	Bryant Creek Formation	Nearshore, restricted, epeiric ramp	Pot casts, gutter casts	Present		Lukasik and James, 2003, *Journal of Sedimentary Research* ; Lukasik and James, 2006, *Geology Society, London, Special Publication*
Neogene	Peru	Camana Formation	Delta front	Sole marks (gutter casts)	Present		Alván and von Eynatten, 2014, *Journal of South American Earth Sciences*
Neogene	Iran	Darkhunish Shale Unit	Neritic to deeper shallow marine	Flute casts	Present		McCall, 2002, *Geological Society, London, Special Publication*
Neogene	Austria	Grund Formation	Storm-dominated shelf, sublittoral	Groove marks	Present		Roetzel and Pervesler, 2004, *Geologica Carpathia* ; Zuschin et al., 2005, *Palaios*
Neogene	Iran	Jaghin Unit	Deltaic, paralic or estuarine (restricted)	Flute casts, prod marks	Present		McCall, 2002, *Geological Society, London, Special Publication*
Neogene	Japan	Kawaguchi Formation	Shelf, sub-SWB and deeper marine	Sole marks	Present		Tokuhashi, 1996, *Sedimentary Geology*
Neogene	Trinidad	Mayaro Formation	Deltaic	Gutter casts	Present	Gutter casts 2-50 cm deep, 10-20 cm wide, up to m scale	Bowman and Johnson, 2014, *Sedimentology* ; Bowman, 2016, *Geological Society, London, Special Publications* ; Dasgupta et al., 2016, *Journal of Sedimentary Research*
Neogene	Iran	Mishan Formation	Lagoonal to sabkha/supratidal	Groove marks	Present		Pirouz et al., 2016, *Geological Society of America Special Paper*
Neogene	Turkey	not specified ("upper unit", Ermenek platform)	Shallow marine distal ramp	Gutter casts	Present		Quiquerez and Dromart, 2006, *Geological Magazine*
Neogene	Italy	not specified (Siena Basin)	Shoreface, deltaic	(Putative) flute casts, groove casts, gutter casts	Present		Martini and Sandrelli, 2015, *Sedimentology*
Neogene	Iran	Roksha Unit	Inner to outer shelf, estuarine	Flute casts, groove casts, prod marks	Present		McCall, 2002, *Geological Society, London, Special Publication*
Neogene	Iran	Sabz Unit	Neritic	Flute casts	Present		McCall, 2002, *Geological Society, London, Special Publication*
Neogene	Borneo	Sandaken Formation	Storm-influenced middle shoreface	Gutter casts	Present	Gutter casts up to >5 m wide, m-scale depth	Noad, 2015, *GeoConvention 2015: New Horizons*
Neogene	Spain	Sorbas Member (Sorbas Basin)	Lagoonal	Prod casts, groove casts	Present		Doyle et al., 2000, *Geological Magazine*
Neogene	Italy	Unit II	Deltaic	Sole marks	Present		Palladino, 2011, *Basin Research*
Neogene	Malaysia	Upper Cycle V	Shallow marine	Putative gutter casts (unfigured)	Present		Rahman et al., 2014, *Marine and Petroleum Geology*
Neogene-Quaternary	Taiwan	Liuchungchi Formation	Outer shelf to upper slope	Sole marks	Present		Hong, 1997, *Journal of Asian Earth Sciences*
Quaternary	USA	Merced Formation	Nearshore shallow marine	Gutter casts	Common	Gutter cast diameter cm- to dm-scale (average ~10 cm)	Chiocci and Clifton, 1991, *SEPM Special Publication*
Quaternary	USA	modern sediments	Outer shelf to upper rise	Epirelief 'sole' marks, tool marks, undichnia	Locally common		Stanley, 1971, *Journal of Sedimentary Petrology*
Quaternary	Antarctica	modern sediments	Shelf and upper rise	Epirelief iceberg gouges (tool marks)	Rare		Harris and O'Brien, 1996, *Geo-Marine Letters*
Quaternary	Australia	modern sediments	Backshore, estuary, water level <10 cm deep)	Epirelief tool marks, scratch circles	Present		Jones, 2006, *Australian Journal of Earth Sciences*

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Quaternary	Abu Dhabi	modern sediments	Intertidal	Epirelief gouges (flutes, grooves)	Abundant		Friedman and Sanders, 1974, *Journal of Sedimentary Petrology*
Quaternary	Italy	not specified (Arente delta complex, Crati Basin)	Prodelta, offshore, sub-WB	Groove marks, tool marks	Present		Fabbricatore et al., 2014, *Italian Journal of Geosciences*

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