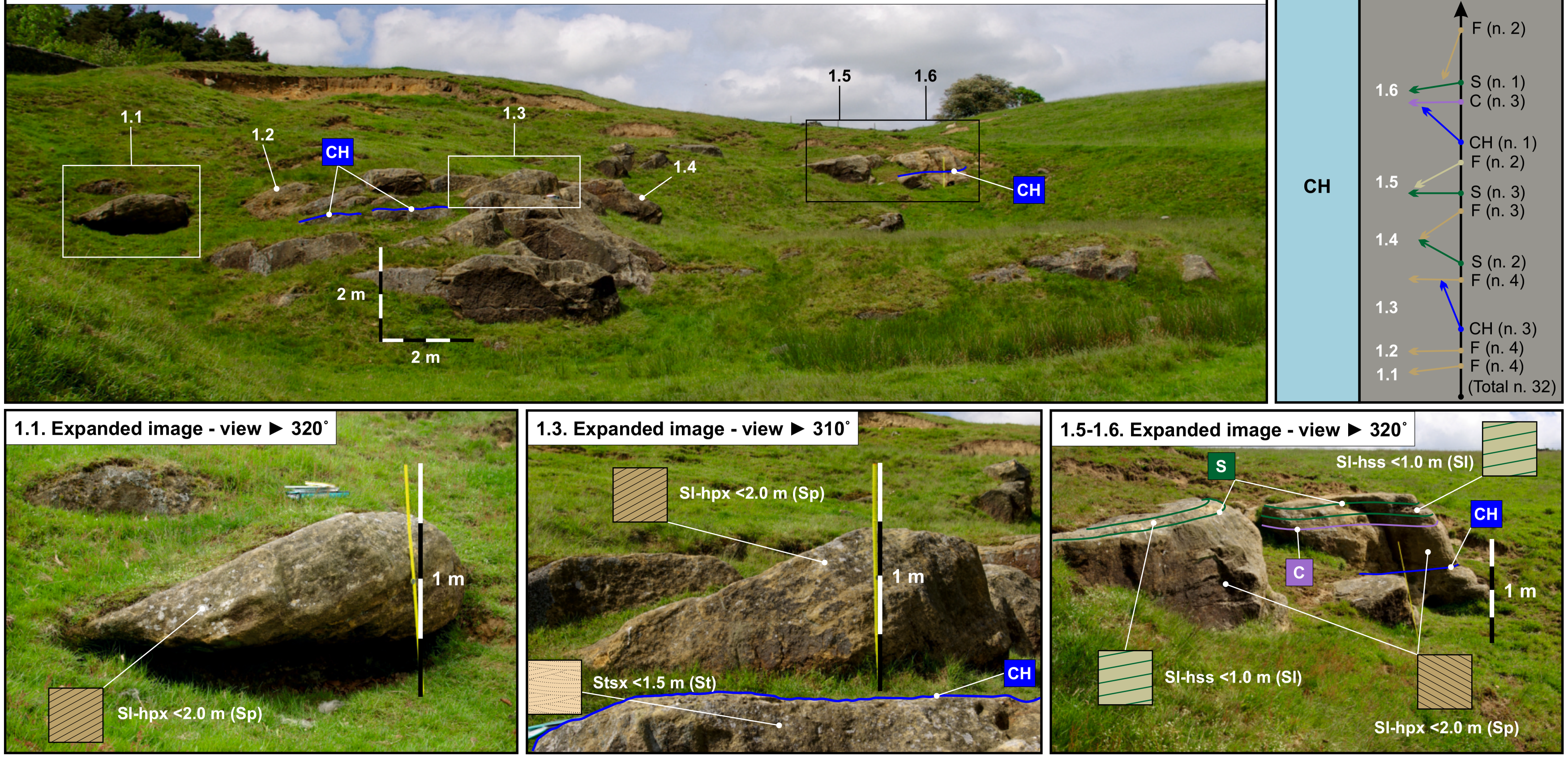
Fig. 4.4 Location 1 - Fewston (Disused Quarry - Outcrops 1.1-1.6) - Grid ref: SE 18479 54821 - Elevation: ~188 m O.D. - Main view ► 360˚



Interpretation: (Outcrops 1.1-1.6) Palaeocurrent data imply deposition was influenced by westerly palaeocurrents (Fig. 4.4A). Coset and set thicknesses suggest variable channel depths and sediment input; a maximum set thickness of ~1.10 m (facies Sl-hpx <2.0 m) indicates that the maximum barform thickness was ~3.30 m (cf. Leclair, 2011). Therefore, given that bar heights may adjust between half and bankfull depth, the maximum depth of host channel was probably between 3.30 m and 6.60 m, respectively (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014) (Fig. 4.6). The lag deposits (Ss-lp-lag) associated with facies Stsx <1.5 m and Sl-hpx <2.0 m (Outcrop 1.3) and facies Sl-hpx <2.0 m (Outcrop 1.6), respectively, likely represent basal flood deposits and high-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Lag deposits may also denote the location of channel thalweg/axial regions (Fidolini *et al.*, 2013; Ghinassi *et al.*, 2014), where relatively larger bedforms develop (Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such locations would have facilitated the deposition of facies Stsx <1.5 m (Outcrops 1.3-1.4) and Sl-hpx <2.0 m (Outcrops 1.1-1.4 and 1.6) which likely represent net sediment (dune) deposition during falling-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011) for sets <1.0 m, or either downstream migration of a transverse bar (2D macroform, part of) (cf. Smith, 1972), or a lobate unit bar component (2D mesoform) (cf. Bridge & Lunt, 2006; Ashworth *et al.*, 2011) for sets ≥1.00 m (facies Sl-hpx <2.0 m, Outcrop 1.4), as sets ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. Such facies may also account for localised thalweg migration and alterations in flow direction (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). The upper facies of Sl-hss <1.0 m (Outcrops 1.5-1.6) likely represent downstream or lateral-accretion of 2D and 3D mesoforms, respectively, within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink *et al.*, 2014), or deposition may have been related to bar top vertical-accretion of a channel bar, primarily due to dune stacking and relative shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006). Similarly, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and subject to the inclination of their host bed most sets will climb at a similar angle (Leeder, 1982). Overall, Outcrops 1.1-1.6 likely represent a relatively broad and deep laterally stacked channel fill elements displaying predominantly westerly palaeocurrents.

Fig. 4.5 Location 1 - Fewston (Disused Quarry)
Metrics Plot and Palaeocurrent Azimuths

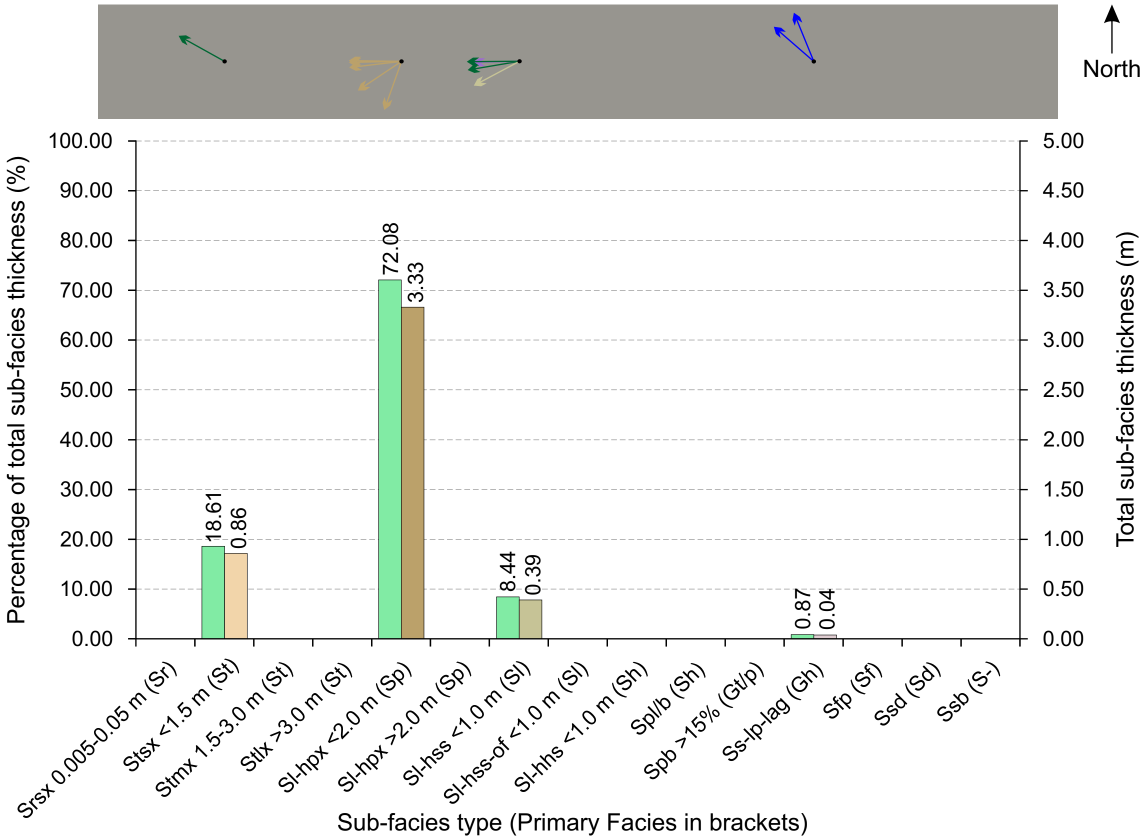


Fig. 4.6 Location 1 - Fewston (Disused Quarry)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

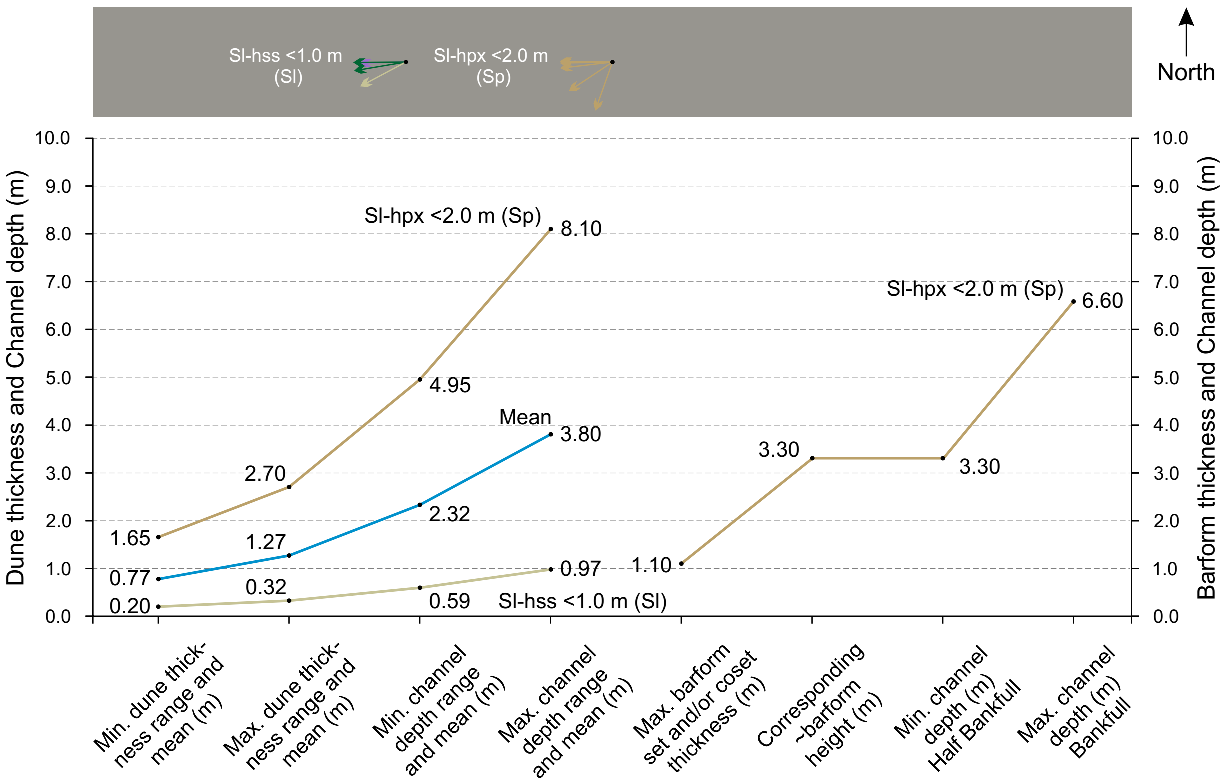
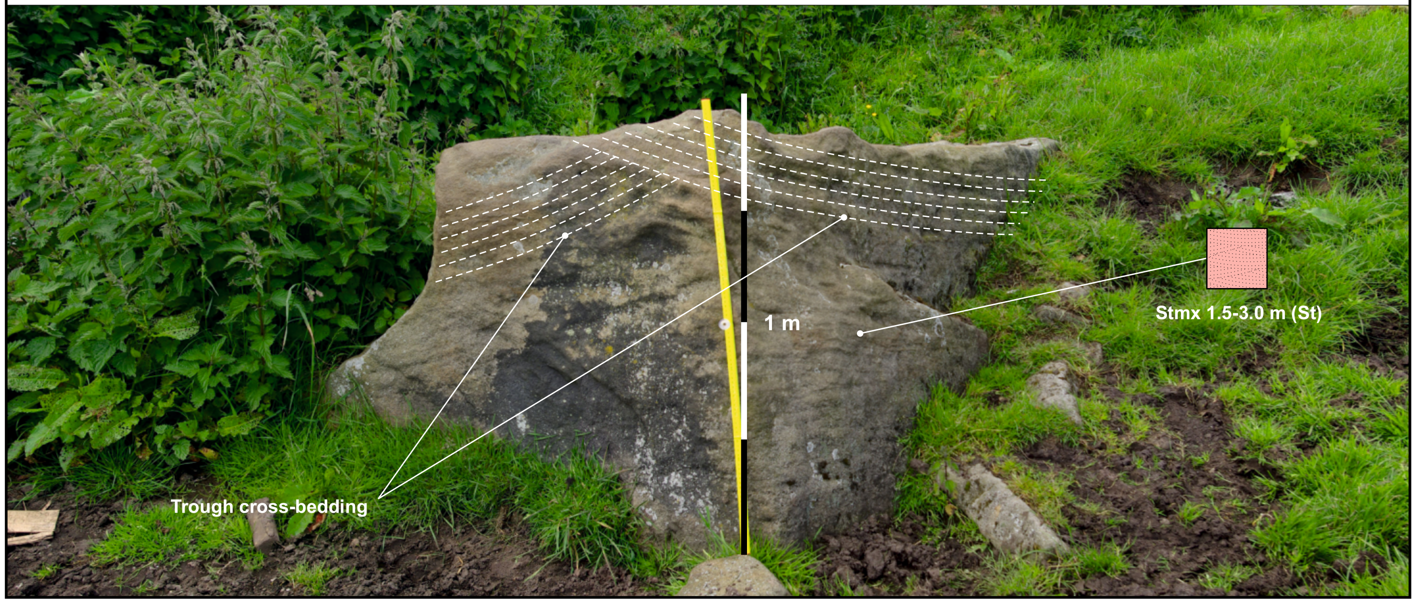
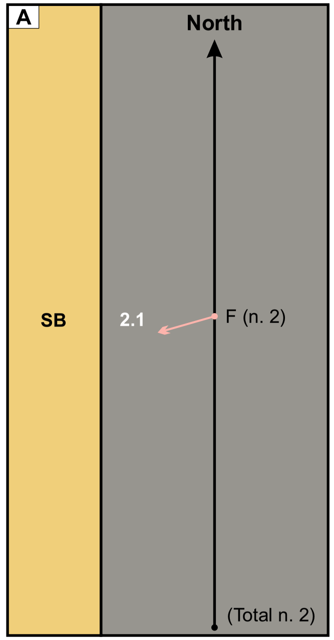
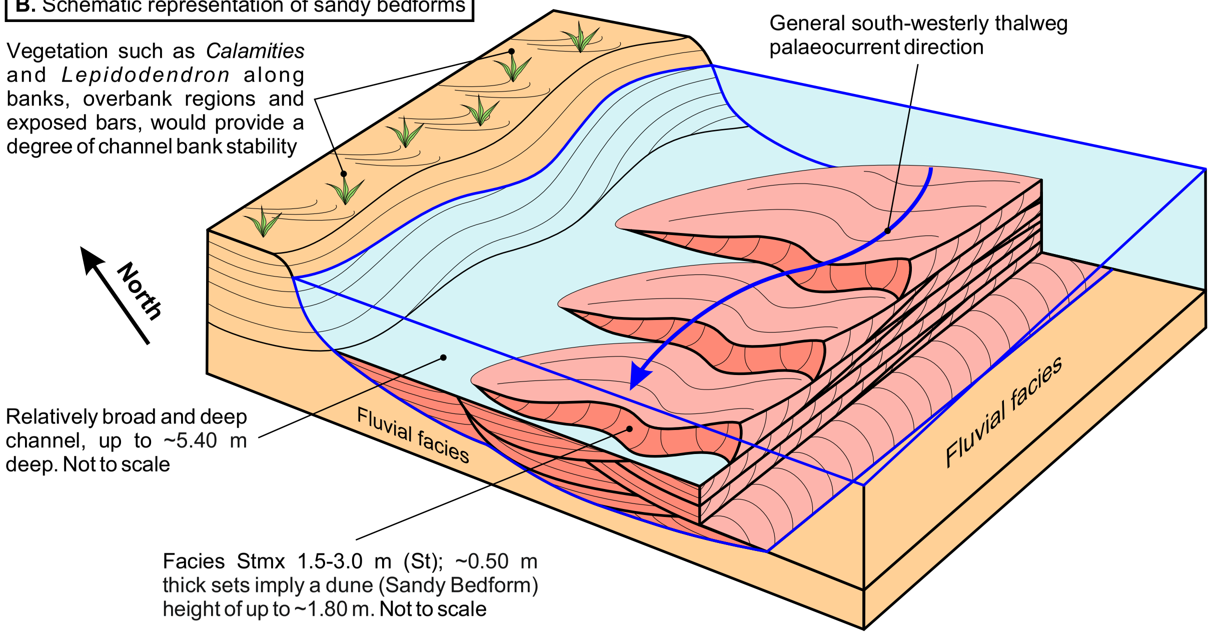


Fig. 4.4 Location 2 - Sandy Gate Road (Disused Quarry - Outcrop 2.1) - Grid ref: SE 15120 59230 - Elevation: ~280 m O.D. - Main view ▶ 250°





B. Schematic representation of sandy bedforms



Interpretation: (Outcrop 2.1) Although limited, palaeocurrent data imply south-westerly migration (Fig. 4.4A) and subsequent deposition of medium-scale 3D mesoforms likely facilitated by a flood event (rising-flow stage) and associated falling-flow stage, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). A set thickness of ~0.50 m suggests that the maximum dune height and channel depth was ~1.80 m and ~5.40 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). Such cross-bedding implies downstream migration and aggradation of sandy bedforms (3D mesoforms) within a relatively broad and deep channel (Fig. 4.4B) with dune migration near to the channel thalweg/axis; large dunes tend to develop towards deeper channel thalweg regions within relatively broad/deep channels (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014).

Fig. 4.5 Location 2 - Sandy Gate Road (Disused Quarry)
Metrics Plot and Palaeocurrent Azimuths

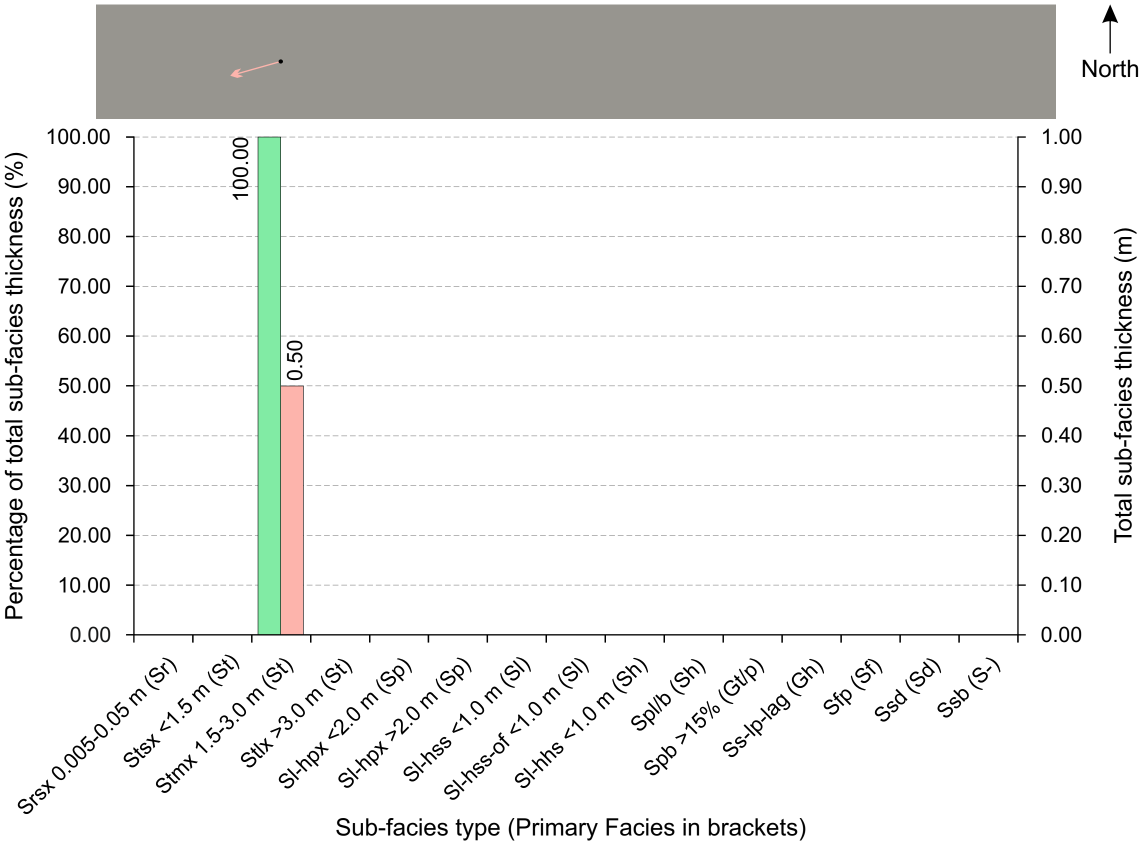


Fig. 4.6 Location 2 - Sandy Gate Road (Disused Quarry)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

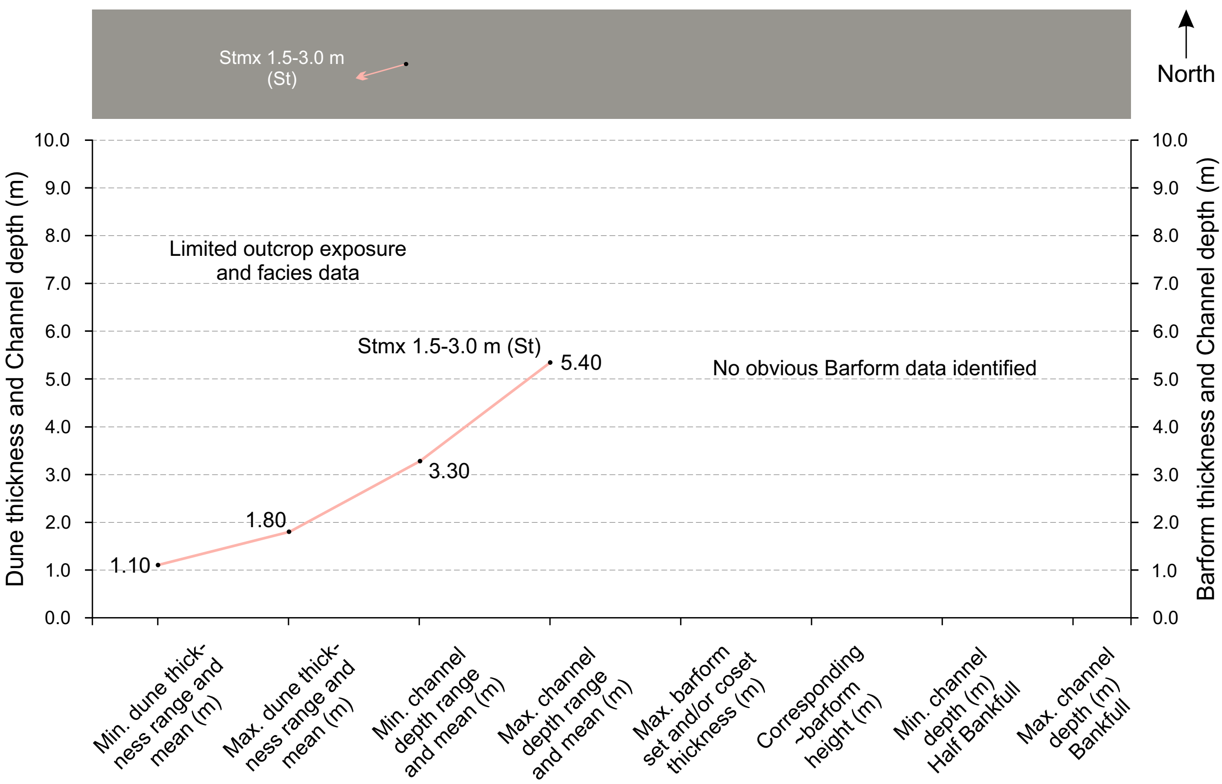
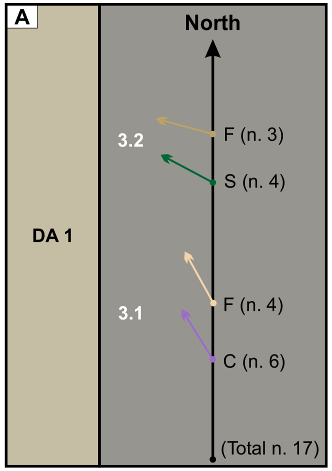
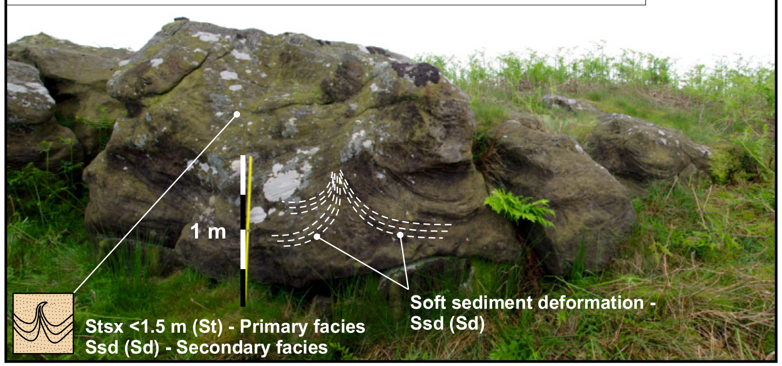


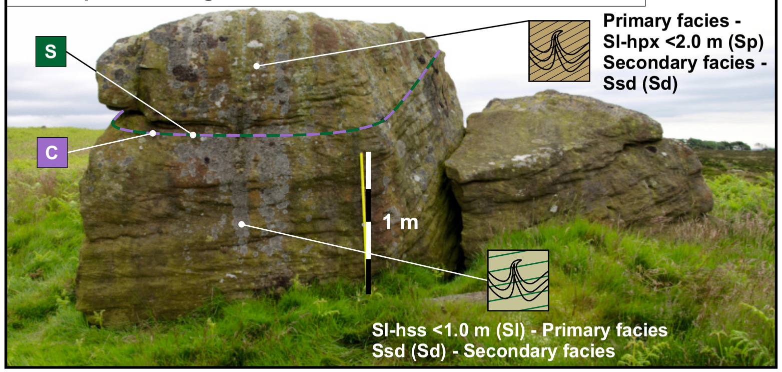
Fig. 4.4 Location 3 - Nell Stones (Outcrops 3.1-3.2) - Elevation: ~271 m O.D. - Main view ▶ 180˚



3.1. Expanded image - Grid ref: SE 14708 59309 - view ▶ 165˚



3.2. Expanded image - Grid ref: SE 14644 59282 - view ▶ 360˚



Interpretation: (Outcrop 3.1) Outcrop 3.1: Predominantly north to north-westerly (Fig. 4.4A) downstream migration of 3D mesoforms which may have formed along the crest or front/tail of a migrating bar (macroform) (cf. Allen, 1982; Haszeldine, 1983b; Miall, 2010b; Ashworth *et al.*, 2011). A set thickness of ~0.30 m equates to a dune height (~1.10 m) which implies moderate sediment input into a relatively deep channel (~3.25 m deep; Fig. 4.6) that was subjected to turbulent flow conditions, likely influenced by high-flow stage facilitating dune migration and the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); collectively, such mesoforms may form unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009). Evidence of soft sediment deformation (i.e. dish and flame structures, facies Ssd) implies loss of grain stability (liquefaction) within unconsolidated water laden sediments, probably facilitated by sudden overburden through rapid sediment deposition (Collinson *et al.*, 2006) post flood and/or syn-sedimentary tectonic activity post deposition.

Outcrop 3.2: The north-westerly (Fig. 4.4A) downstream migration of stacked sets (facies Sl-hss <1.0 m) likely indicate recurring bedform migration, probably as a train of dunes over the crest or front/tail of a larger bar (macroform) (cf. Allen, 1982; Haszeldine, 1983b; Miall, 2010b; Ashworth *et al.*, 2011), thereby forming components of a larger host dune coset (cf. Haszeldine, 1983b). A cumulative coset thickness of ~1.40 m indicates a maximum bar height and channel depth of ~1.80 m and ~3.60 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). Individual set thicknesses (~0.15 m) suggest limited sediment input (i.e. dune height of ~0.50 m) into a relatively shallow channel (~1.60 m deep), likely influenced by high-flow stage which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011). Subsequent deposition of facies Sl-hpx <2.0 m likely represent net sediment deposition during falling-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011) of a lobate unit bar (3D mesoform) (cf. Bridge & Lunt, 2006; Ashworth et al., 2011); a set thickness ≥1.00 m likely denotes unit bars (Bridge & Lunt, 2006). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.50 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. A preserved set thickness of ~1.00 m suggests a maximum barform thickness of ~3.00 m (cf. Leclair, 2011) and depth of host channel of between 3.00 m and 6.00 m, respectively (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014) (Fig. 4.6). Evidence of soft sediment deformation (i.e. dish and flame structures, facies Ssd), see above interpretation.

Fig. 4.5 Location 3 - Nell Stones
Metrics Plot and Palaeocurrent Azimuths

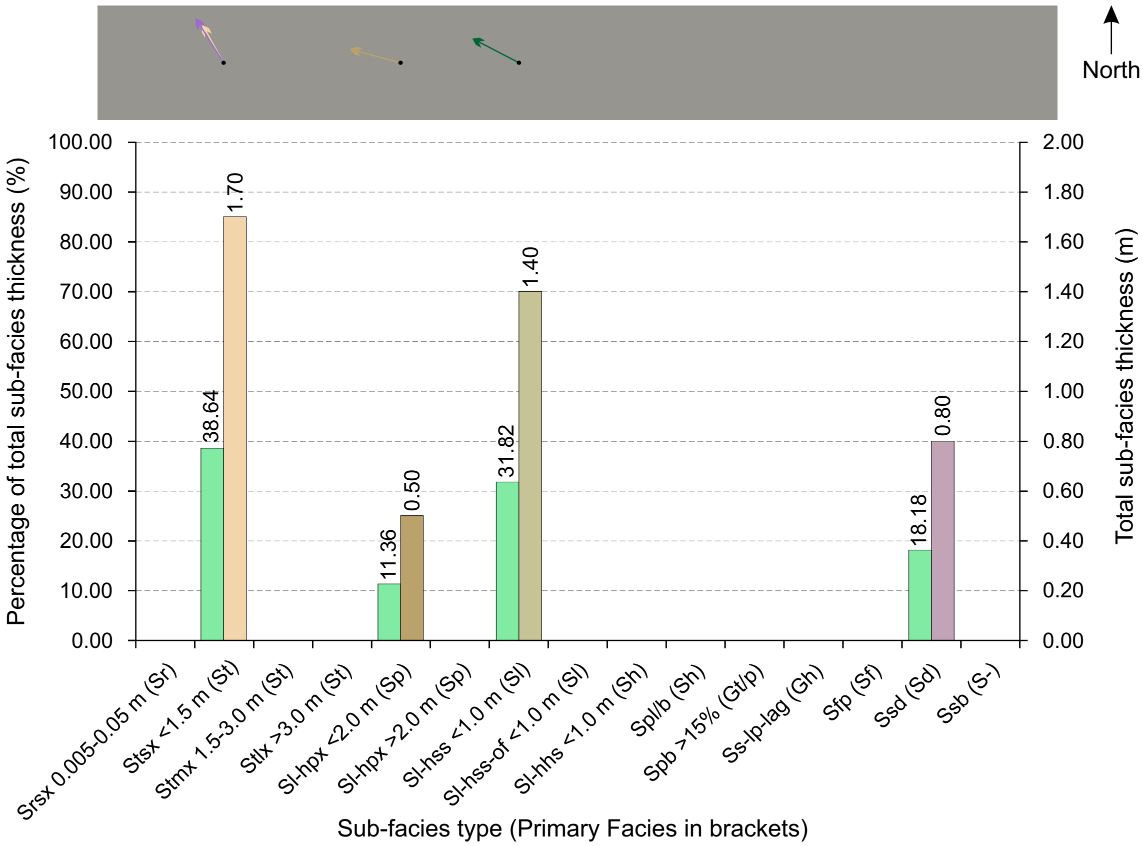


Fig. 4.6 Location 3 - Nell Stones
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

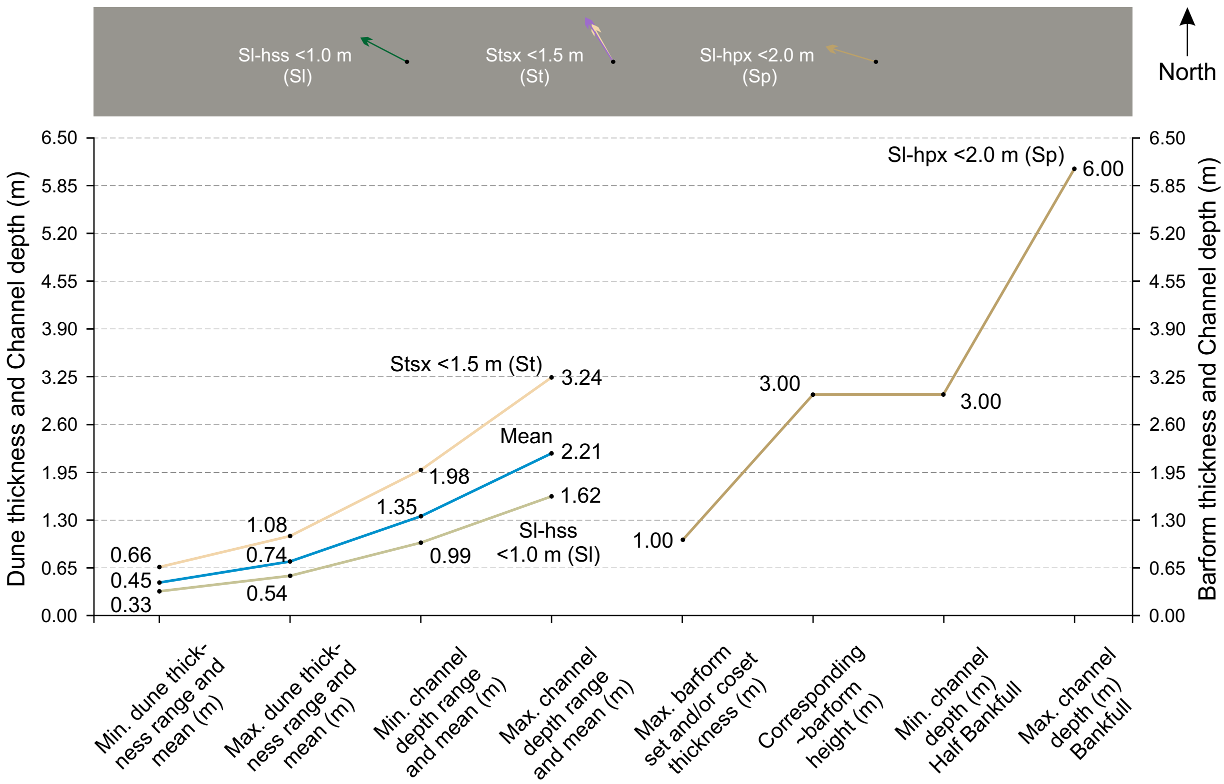
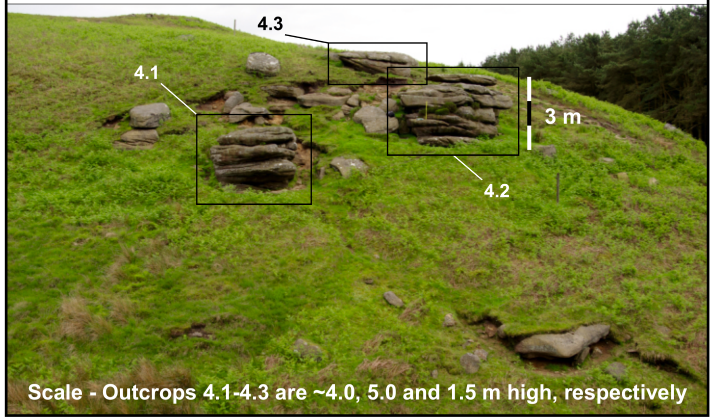
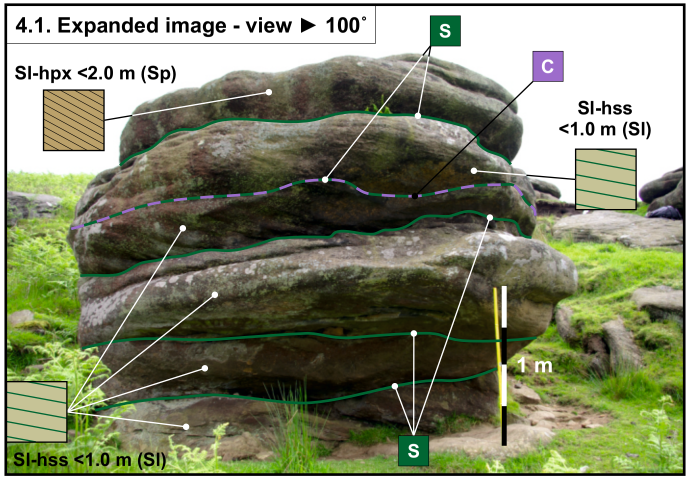
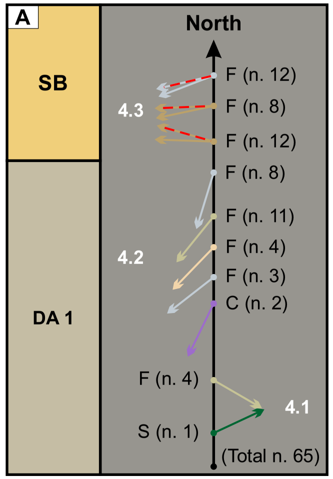
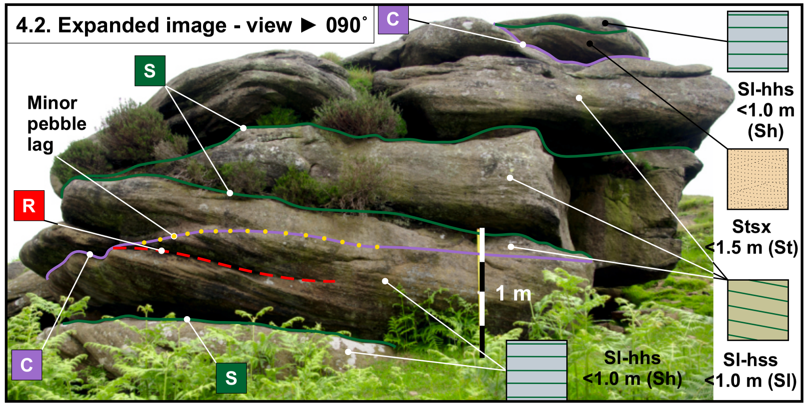


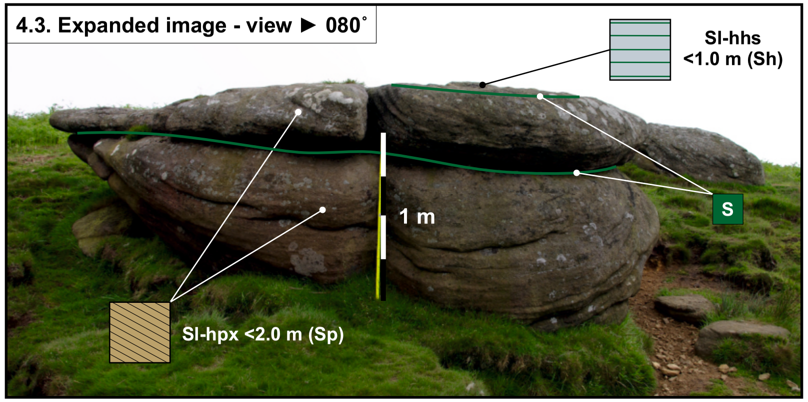
Fig. 4.4 Location 4 - Far Comb Hill (Outcrops 4.1-4.3) - Grid ref: SE 13910 59371 - Elevation: ~240 m O.D. - Main view ► 110˚











Interpretation: Although palaeocurrent data is limited, sediment deposition appears to have been influenced by south-easterly (Outcrop 4.1), south-westerly (Outcrop 4.2) and westerly palaeocurrents (Outcrop 4.3) (Fig. 4.4A). Variable set thicknesses (Outcrops 4.1-4.3) of between 0.10 m (facies Sl-hss <1.0 m) and 0.80 m (facies Sl-hhs <1.0 m) implies a maximum dune height and channel depth of ~2.90 m and 8.65 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~1.10 m (facies Sl-hss <1.0 m) equates to a maximum bar height and channel depth of ~1.60 m and 3.25 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). The variable thicknesses and sub-horizontal sets (Outcrop 4.1) associated with facies Sl-hss <1.0 m imply variable sediment input, flow velocity and downstream-accretion, respectively, of 3D mesoforms (cf. Coleman, 1969; Bristow, 1987, 1993a; Collinson *et al.*, 2006; Ashworth *et al.*, 2011).

Outcrop 4.2: Variable foreset azimuth-dips (facies Sl-hhs <1.0 m) imply that the outcrop base formed part of a transverse bar (2D macroform) (cf. Smith, 1972) and the intermittent lag deposit (Ss-lp-lag) likely represents scouring (Miall, 2010b) or winnowing (cf. Collinson *et al.*, 2006) processes rather than a fifth-order channel surface. Variable palaeocurrents (facies Sl-hss <1.0 m) imply downstream migration of stacked sets (3D mesoforms), probably over the front/tail of a larger bar (macroform) (cf. Allen, 1982; Haszeldine, 1983b; Bristow, 1993b; Miall, 2010b; Ashworth *et al.*, 2011); facies Stsx <1.5 m also suggests downstream dune migration (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011). The shallow channel conditions associated with facies Sl-hhs <1.0 m implies waning flow, aggradation of 3D mesoforms and channel fill (cf. Cant & Walker, 1976; Ashworth et al., 2011; Reesink *et al.*, 2014).

Outcrop 4.3: Facies Sl-hpx <2.0 m implies an increase in channel depth and net sediment input, likely facilitated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). The ~1.10 m thick set implies downstream migration of a transverse bar (2D macroform) (cf. Smith, 1972), or lobate unit bar (2D mesoform) (cf. Bridge & Lunt, 2006); Sambrook Smith *et al.* (2006) interpret sets >0.50 m, which possess inclined cross-stratification, as a consequence of bar migration. Net sediment deposition of large-scale sandy bedforms during falling-flow stage may cause localised thalweg migration and alterations in flow direction (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). Alternatively, fault/tectonic (syn-sedimentary) activity and/or subsidence along the North Craven Fault may have influenced palaeoflow through lateral tilting (cf. Kane *et al.*, 2010; Fidolini *et al.*, 2013).

Fig. 4.5 Location 4 - Far Comb Hill
Metrics Plot and Palaeocurrent Azimuths

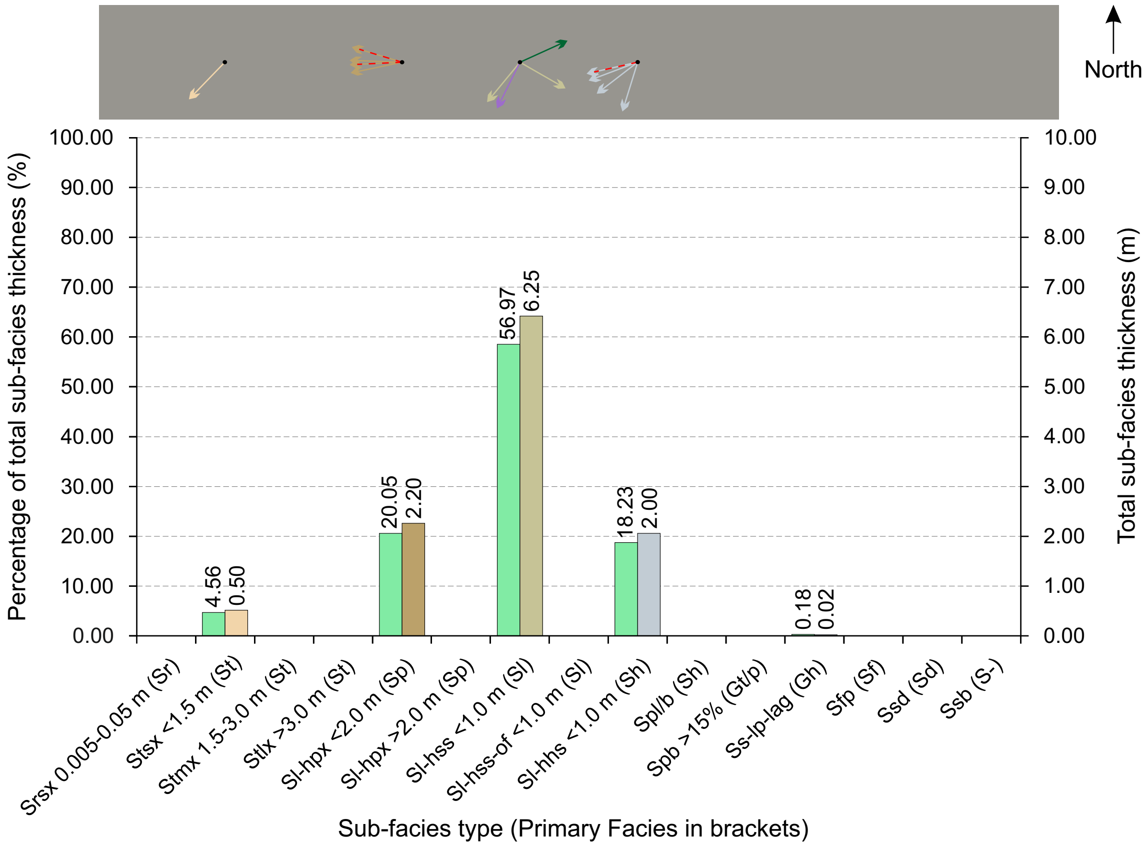


Fig. 4.6 Location 4 - Far Comb Hill
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

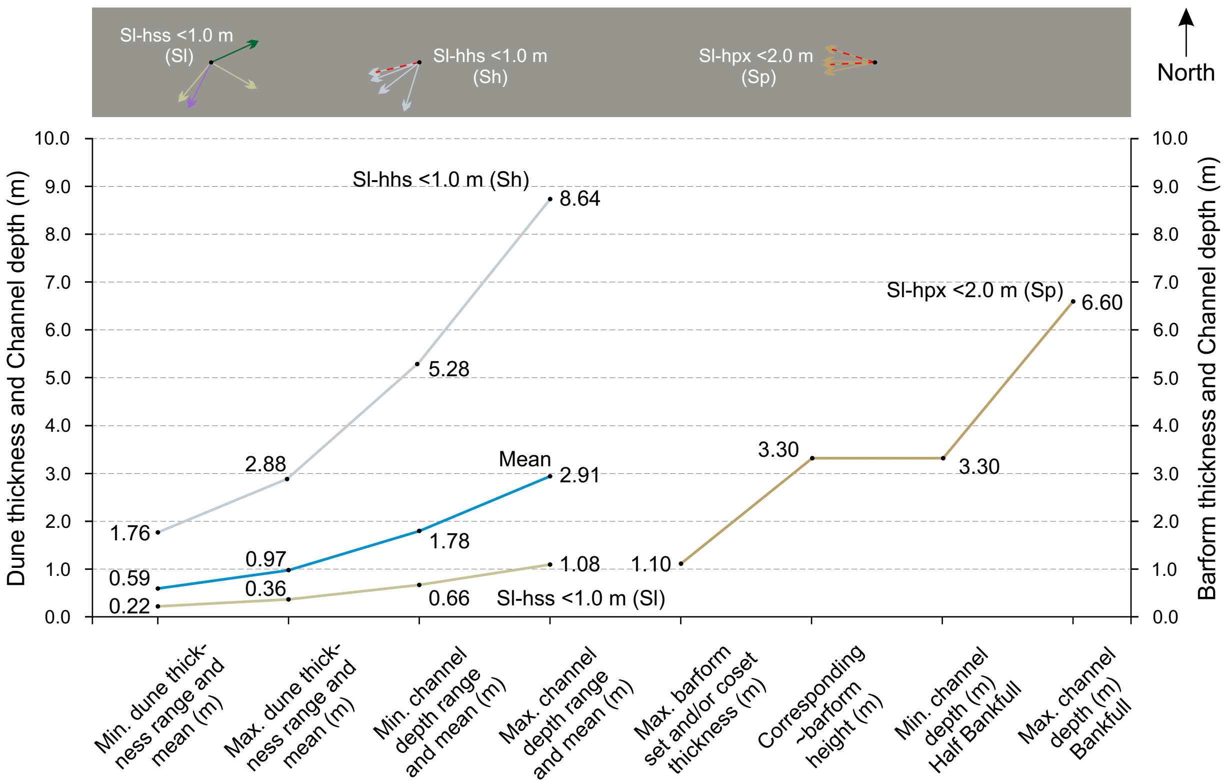
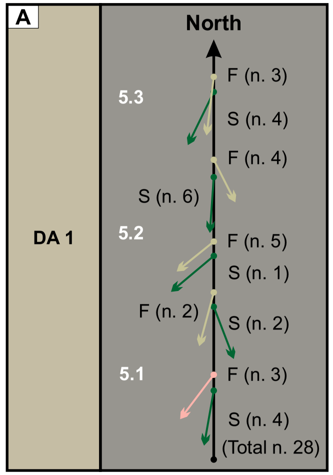
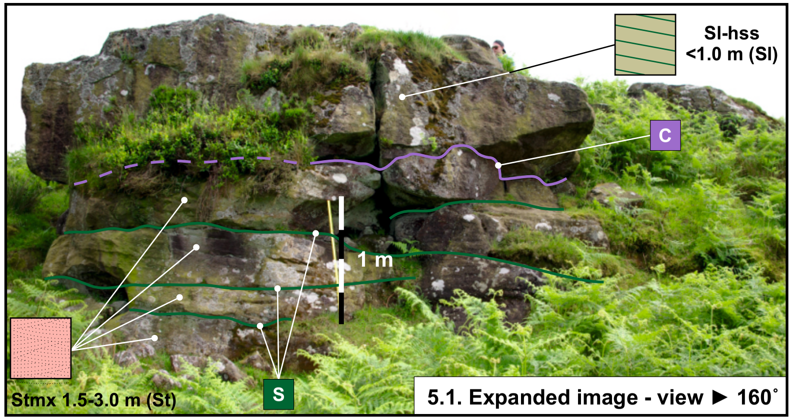
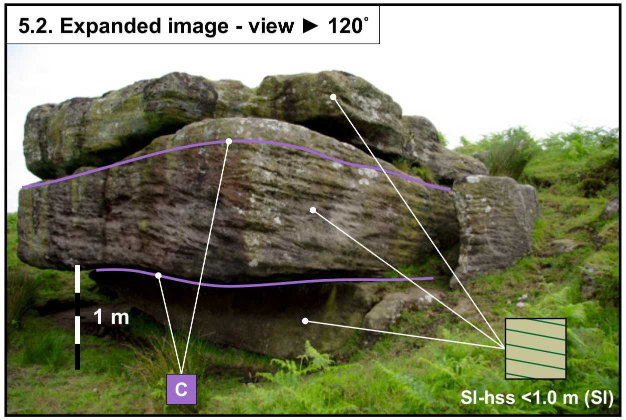


Fig. 4.4 Location 5 - Hood Crag (Outcrops 5.1-5.3) - Grid ref: SE 13594 59221 - Elevation: ~260 m O.D. - Main view ▶ 160˚

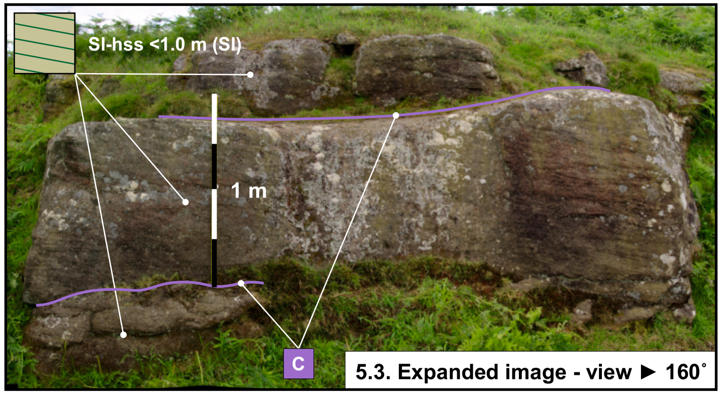




5.1. Expanded image - view ▶ 160˚



5.2. Expanded image - view ▶ 120˚



5.3. Expanded image - view ▶ 160˚

Interpretation: (Outcrops 5.1-5.3) Sediment deposition appears to have been mainly influenced by south to south-westerly palaeocurrents (Fig. 4.4A). Variable set thicknesses (Outcrops 5.1-5.3) of between 0.10 m (facies Sl-hss <1.0 m) and 0.50 m (facies Stmx 1.5-3.0 m) imply a maximum dune height and channel depth of ~1.80 m and 5.40 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~1.50 m (facies Sl-hss <1.0 m) equates to a maximum bar height and channel depth of ~1.90 m and 3.80 m, respectively (cf. Seabrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). Facies Stmx <1.5-3.0 m (Outcrop 5.1) likely represents downstream migration and accretion towards the channel thalweg/axis of a relatively broad and deep channel where large dunes tend to develop (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such 3D mesoforms were probably generated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Facies Sl-hss <1.0 m (Outcrops 5.1-5.3) likely represent migratory bedforms that developed in a shallow channel (cf. Ashworth *et al.*, 2011), possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976). Cosets of facies Sl-hss <1.0 m may also represent: i. downstream migration and aggradation of small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); ii. latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014) influenced by high-flow stage, which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); iii. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006), i.e. sets divided by first-order boundaries representing repeated bedform migration as a train of dunes (dune stacking); or, iv. components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). Preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982).

Fig. 4.5 Location 5 - Hood Crag
Metrics Plot and Palaeocurrent Azimuths

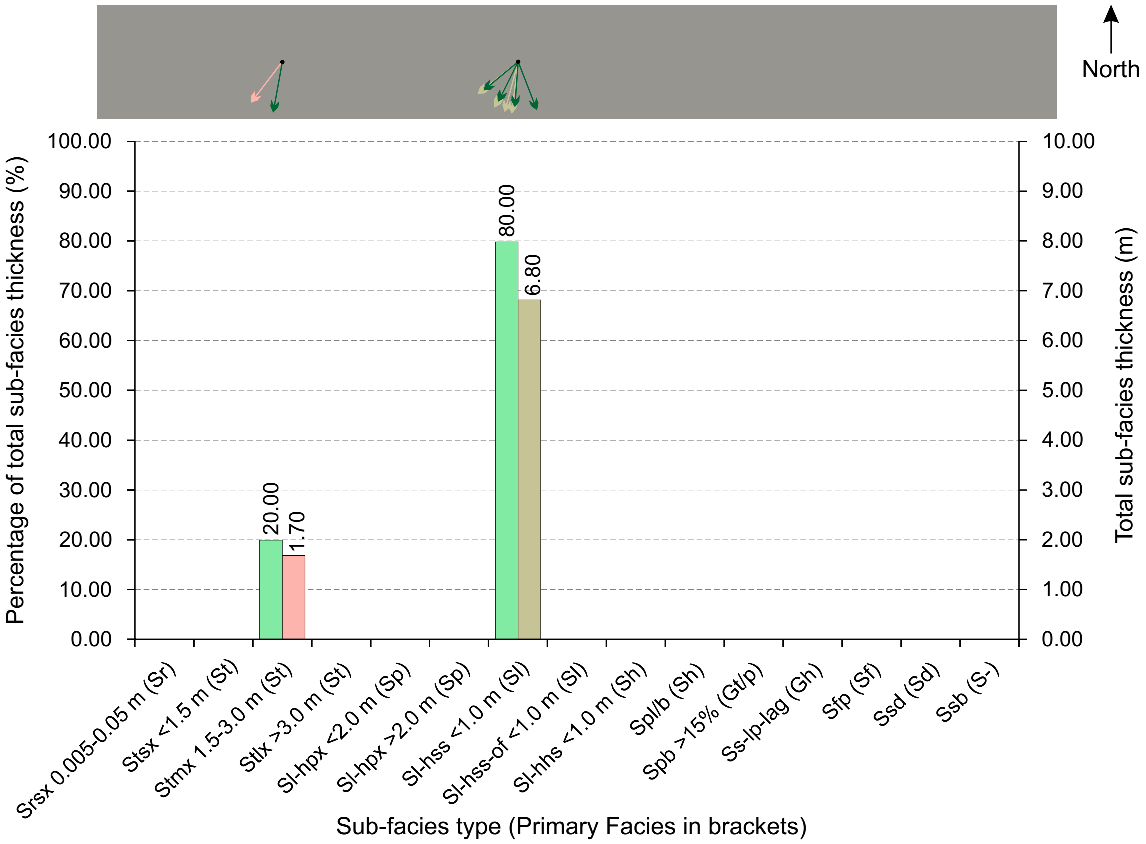


Fig. 4.6 Location 5 - Hood Crag
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

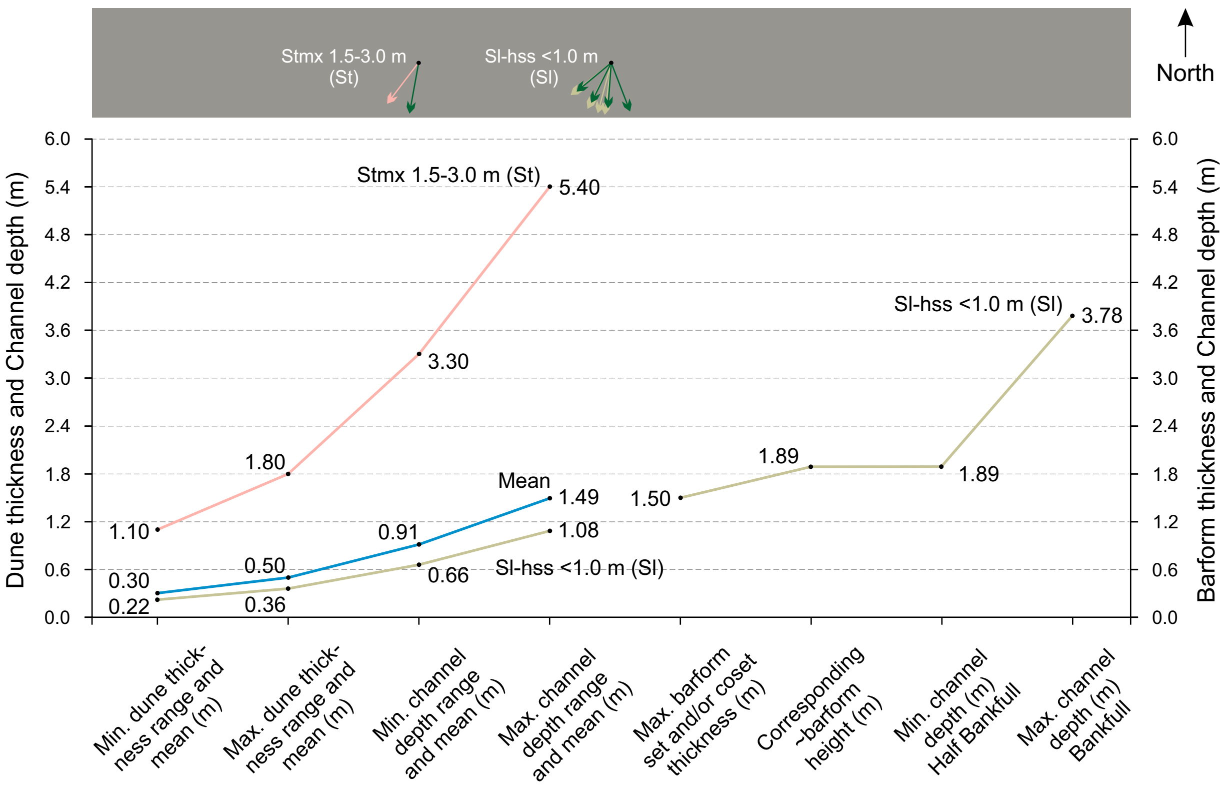
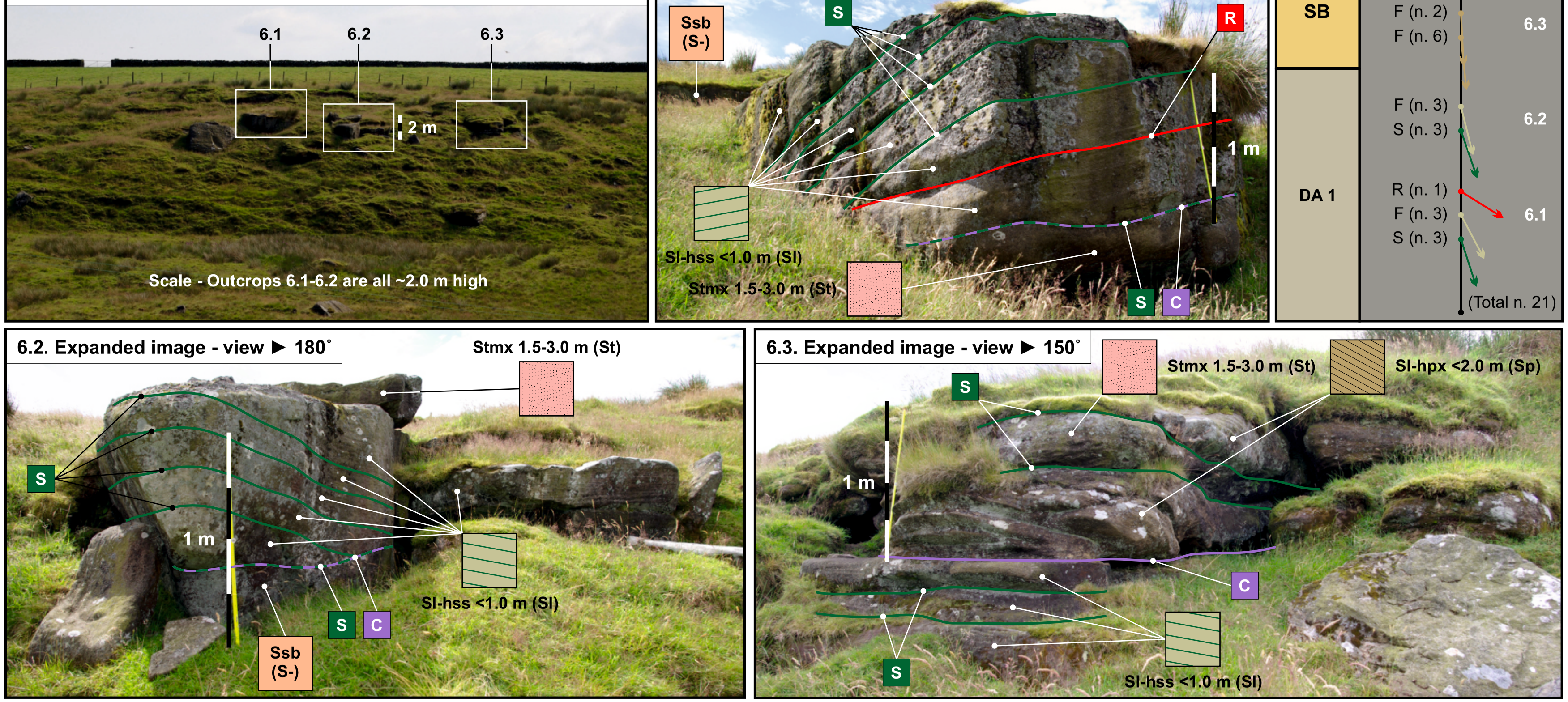


Fig. 4.4 Location 6 - Duke's Hill (Outcrops 6.1-6.3) - Grid ref: SE 13755 58066 - Elevation: ~245 m O.D. - Main view ► 180˚



Interpretation: (Outcrops 6.1-6.3) Although palaeocurrent data is limited, sediment deposition appears to have been influenced by south-south-easterly palaeocurrents (Fig. 4.4A). Variable set thicknesses (Outcrops 6.1-6.3) of between 0.10 m (facies Sl-hss <1.0 m) and 0.60 m (facies Sl-hpx <2.0 m) implies a maximum dune height and channel depth of ~2.15 m and 6.50 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~1.40 m (facies Sl-hss <1.0 m) equates to a maximum bar height and channel depth of ~1.90 m and 3.85 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6).

Outcrop 6.1 and 6.2: Facies Stmx 1.5-3.0 m likely represents downstream migration and accretion of 3D mesoforms that developed towards the thalweg/axis of a relatively broad and deep channel where large dunes tend to develop (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such facies were probably generated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Facies Sl-hss <1.0 m likely represents migratory bedforms (i.e. 2D mesoforms) that developed in a relatively shallow channel (cf. Ashworth *et al.*, 2011), possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976). Such channel conditions imply waning flow, aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Cosets of facies Sl-hss <1.0 m may also represent: i. downstream migration and aggradation of small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); ii. latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014) influenced by high-flow stage, which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); iii. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006), i.e. sets divided by first-order boundaries representing repeated bedform migration as a train of dunes (dune stacking); or, iv. components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). Preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). Outcrop 6.3: See interpretations relating to facies Sl-hss <1.0 m and Stmx 1.5-3.0 m. Deposition of facies Sl-hpx <2.0 m implies a substantial increase in channel depth and net sediment input, likely facilitated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). The size of cross-bedding suggests downstream-accretion of sandy bedforms within a relatively broad and deep channel with dune migration near to channel thalweg/axis (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014).

Fig. 4.5 Location 6 - Duke's Hill
Metrics Plot and Palaeocurrent Azimuths

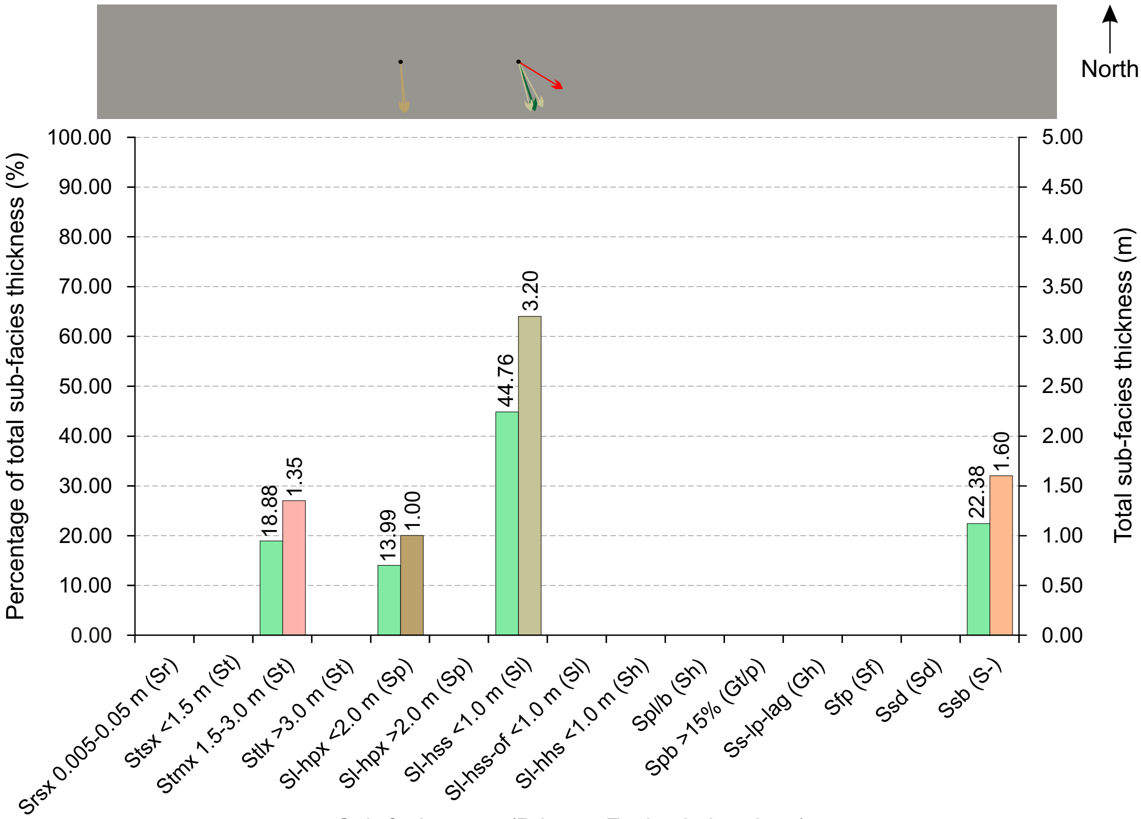


Fig. 4.6 Location 6 - Duke's Hill
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

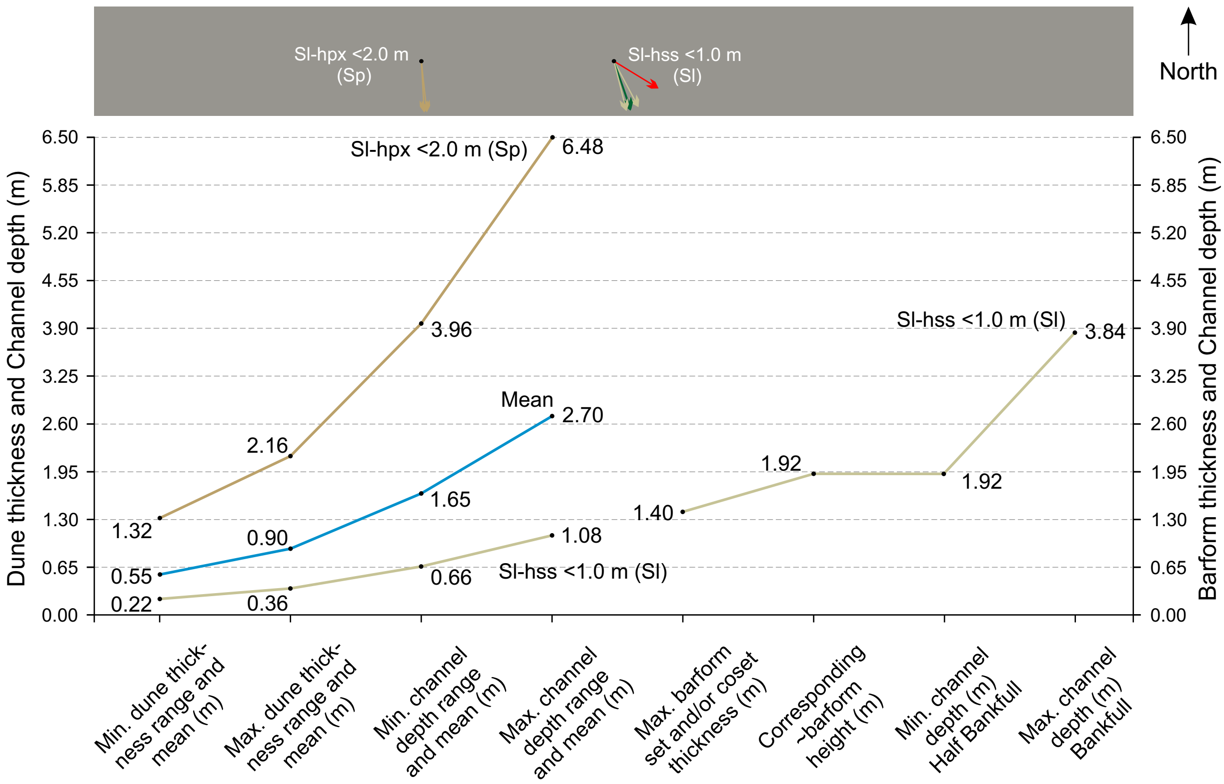
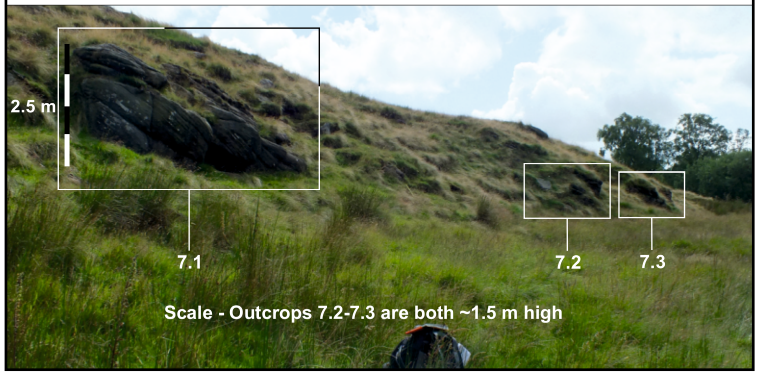
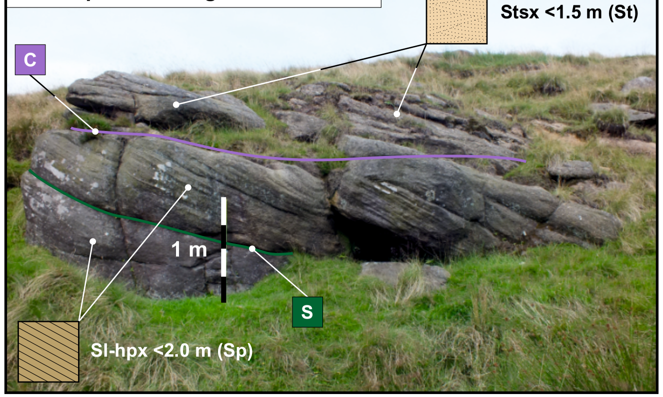
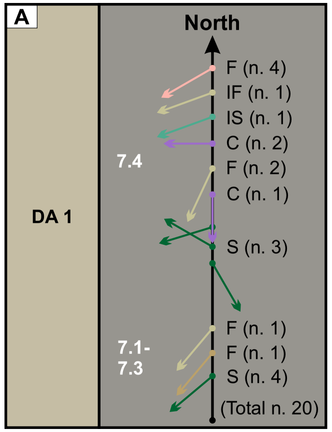


Fig. 4.4 Location 7 - Harrie's Dam (Outcrops 7.1-7.3) - Grid ref: SE 13277 57902 - Elevation: ~243 m O.D. - Main view ► 150˚

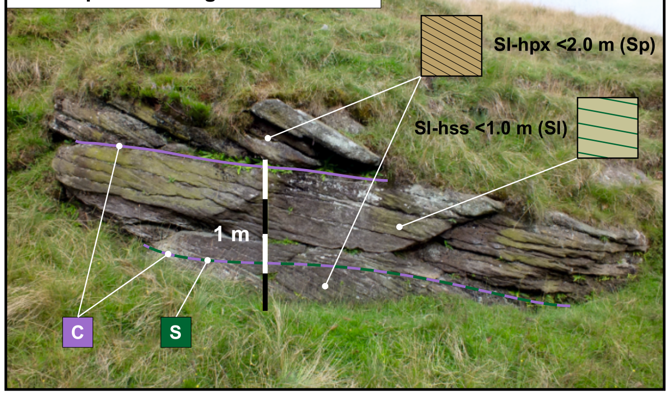


7.1. Expanded image - view ► 080˚

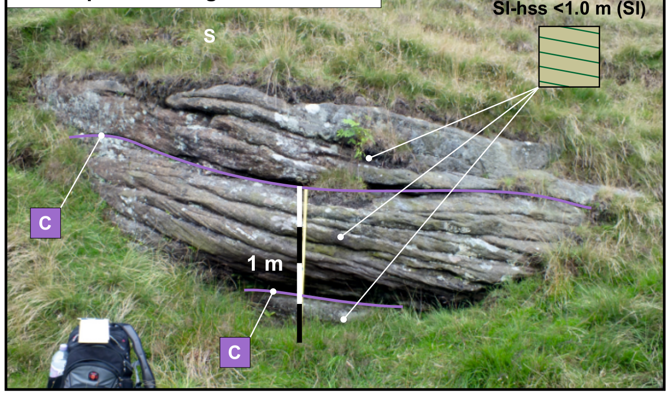




7.2. Expanded image - view ► 080˚



7.3. Expanded image - view ► 080˚



Interpretation: (Outcrops 7.1-7.3) Although palaeocurrent data is limited, sediment deposition appears to have been influenced by south-westerly palaeocurrents (Fig. 4.4A). Variable set thicknesses (Outcrops 7.1-7.3) of between 0.10 m (facies Sl-hss <1.0 m) and 0.75 m (facies Sl-hpx <2.0 m) implies a maximum dune height and channel depth of ~2.70 m and 8.10 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~0.80 m (facies Sl-hss <1.0 m) equates to a maximum dune/bar height and channel depth of ~1.20 m and 2.40 m, respectively (cf. Sambrook Smith *et al*., 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). The facies associated with Outcrops 7.1-7.3 likely represent downstream migratory bedforms with temporal variation in channel depth. Facies Sl-hpx <2.0 m likely represent flood events with an increase in channel depth/flow and net sediment input, thereby likely facilitating sediment migration and aggradation of 2D mesoforms influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al*., 2011). The size of cross-bedding suggests downstream-accretion within a relatively broad and deep channel with dune migration near to the channel thalweg/axis (cf. Reesink & Bridge, 2009; Ashworth *et al*., 2011; Reesink *et al*., 2014). Facies Sl-hss <1.0 m likely represents migratory bedforms (i.e. 2D mesoforms) that developed in a relatively shallow channel (cf. Ashworth *et al*., 2011), possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976). Such channel conditions imply waning flow, aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al*., 2011; Reesink *et al*., 2014). Cosets of facies Sl-hss <1.0 m may also represent: i. downstream migration and aggradation of small-scale unit bars (cf. Sambrook Smith *et al*., 2006; Reesink & Bridge, 2009); ii. latter stages of a channel fill sequence (cf. Reesink *et al*., 2014) influenced by high-flow stage, which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); iii. a series of distinct depositional episodes (cf. Collinson *et al*., 2006), i.e. sets divided by first-order boundaries representing repeated bedform migration as a train of dunes (dune stacking); or, iv. components of a channel bar top (cf. Bristow, 1993b; Best *et al*., 2003; Bridge & Lunt, 2006; Mumpy *et al*., 2007; Miall, 2010b; Ashworth *et al*., 2011). Preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). Outcrop 7.4 (Grid ref: SE 13296 57960; not illustrated) represents variable southerly to westerly (Fig. 4.4A) downstream migratory bedforms with temporal variation in channel depth. Variable palaeocurrents likely represent a migrating thalweg and/or mid-channel bar cosets correlated to facies Stmx 1.5-3.0 m and Sl-hss <1.0 m, respectively. Deposition during falling-flow stage may facilitate localised thalweg migration and alterations in flow direction (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al*., 2011). Alternatively, variable palaeocurrent azimuths imply dune-scale bedforms may have migrated obliquely over, around and down a curved barform front/tail (cf. Haszeldine, 1983b). Facies Stmx <1.5-3.0 m likely denote repeated downstream migration and accretion of 3D mesoforms towards the thalweg/axis of a relatively broad/deep channel (cf. Reesink & Bridge, 2009; Ashworth *et al*., 2011; Reesink *et al*., 2014). Such facies were probably generated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al*., 2011). A 1.00 m thick set (facies Stmx 1.5-3.0 m) equates to a 3.00 m bar height and 6.00 m channel depth (cf. Sambrook Smith *et al*., 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). See above interpretations relating to facies Sl-hss <1.0 m.

Fig. 4.5 Location 7 - Harrie's Dam
Metrics Plot and Palaeocurrent Azimuths

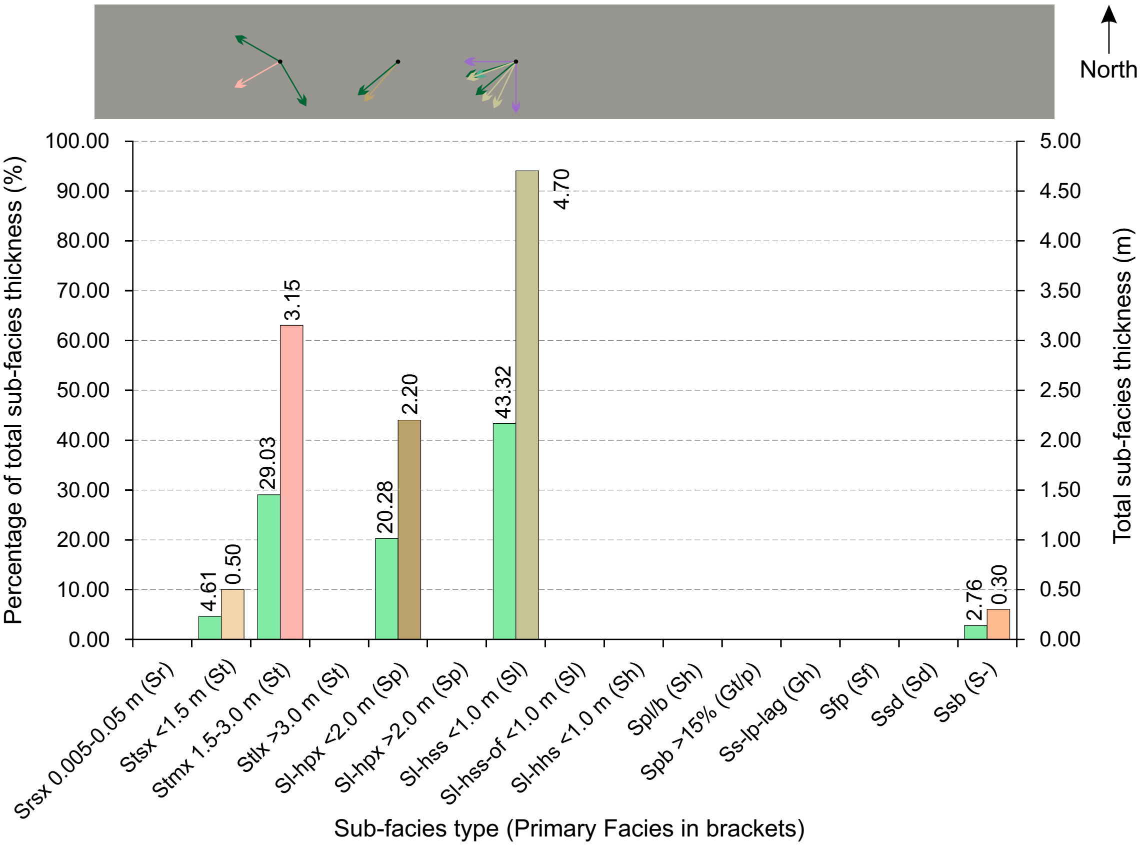


Fig. 4.6 Location 7 - Harrie's Dam
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

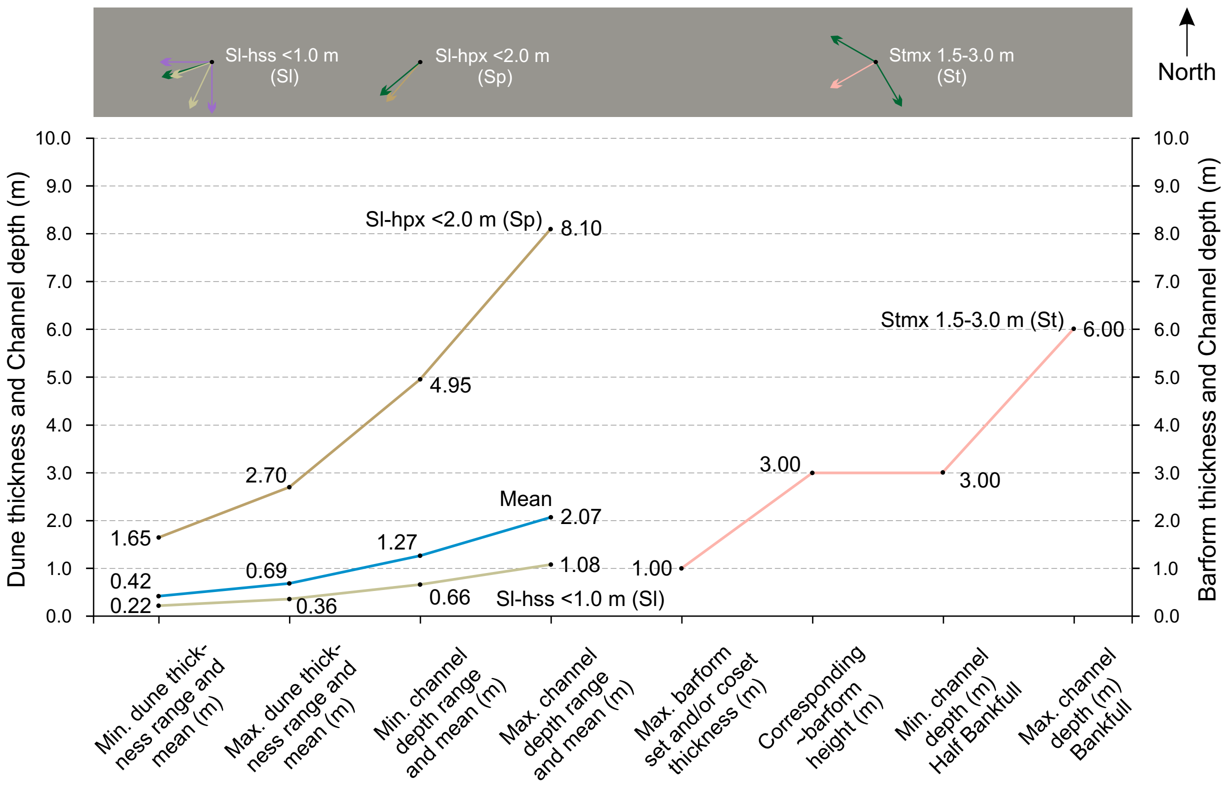
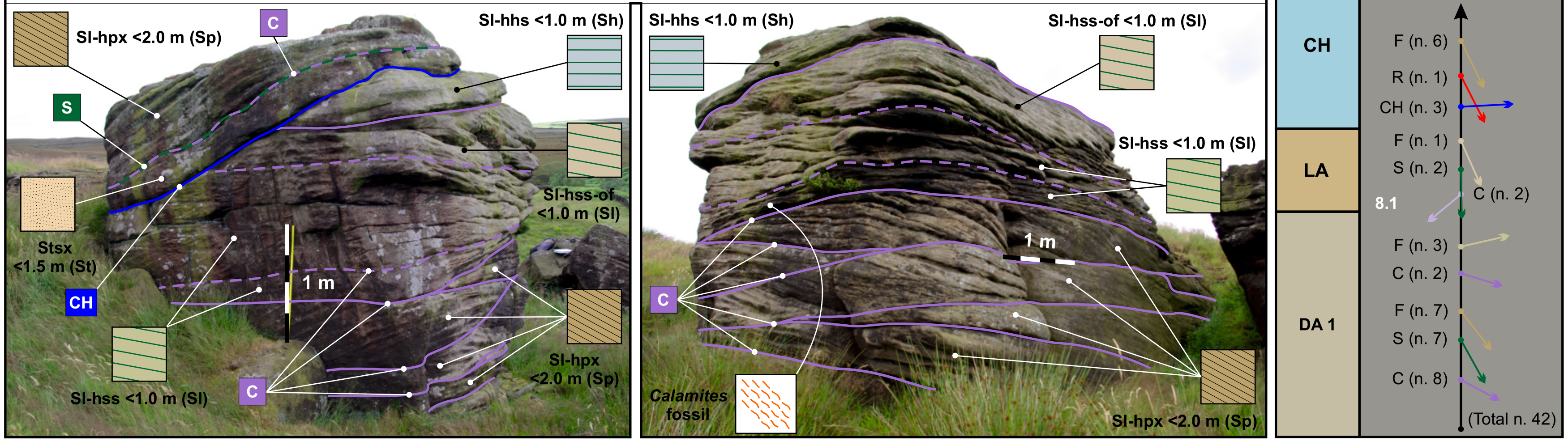
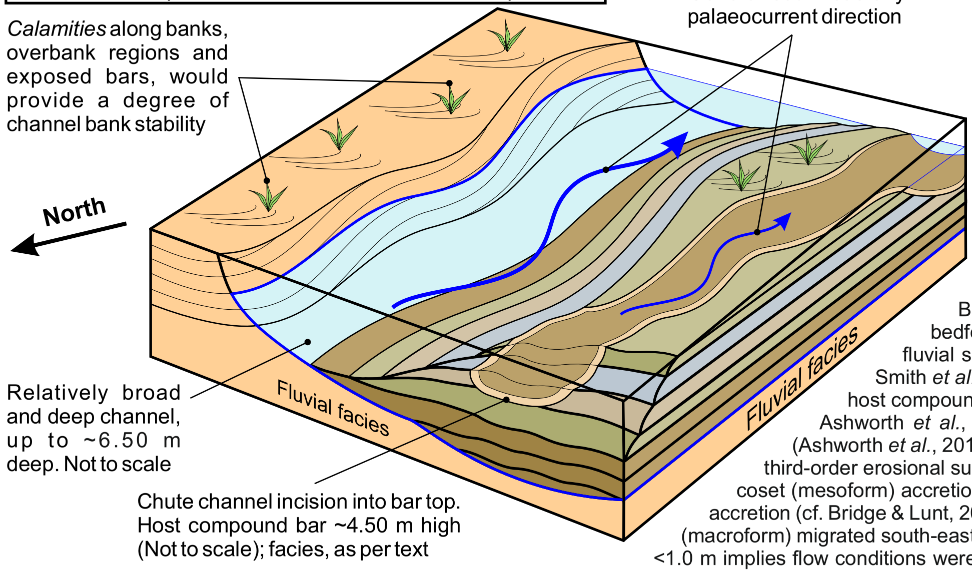


Fig. 4.4 Location 8 - Gill House Crags (Outcrop 8.1) - Grid ref: SE 13371 57994 - Elevation: ~255 m O.D. - Left view ▶ 190˚ - Right view ▶ 090˚



B. Schematic representation of chute channel bar top incision



Interpretation: (Outcrop 8.1) Although palaeocurrent data varies from an easterly to south-westerly direction, the general palaeocurrent direction appears to be towards the southeast (Fig. 4.4A); the variable range of azimuths suggest that dune-scale bedforms may have migrated obliquely over, around and down a curved barform front/tail (cf. Haszeldine, 1983b). Variable set thicknesses of between 0.05 m (facies Sl-hss <1.0 m) and 0.60 m (facies Sl-hpx <2.0 m) implies a maximum dune height and channel depth of ~2.15 m and 6.50 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~0.60 m (facies Sl-hss-of <1.0 m) equates to a maximum dune/bar height and channel depth of ~1.00 m and 2.00 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). Individual sub-horizontal sets of Sl-hpx <2.0 m, Sl-hss <1.0 m and Sl-hss-of <1.0 m likely form components of larger host dune cosets (cf. Haszeldine, 1983b), influenced by high-flow stage which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011). Such cosets may represent migratory mid-channel bar bedform components (cf. Reesink & Bridge, 2009) that likely formed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014) and/or small-scale migrating unit bars (cf. Sambrook Smith *et al.*,2006; Reesink & Bridge, 2009), which in turn likely form components of a much larger host compound bar (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011), although such component coset/unit bar heights coincide with dune heights (Ashworth *et al.*, 2011). The sub-horizontal second-order coset/unit bar bounding surface contacts are likely third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014). Such contacts denote a component of lateral coset (mesoform) accretion and growth of the host compound bar (macroform) through lateral and downstream-accretion (cf. Bridge & Lunt, 2006), alternating between a south-easterly and south-westerly direction, as the main bar (macroform) migrated south-eastwards downstream. The ~0.05 m thick sets related to the ~0.25 m thick coset of Sl-hss <1.0 m implies flow conditions were sufficiently shallow to subdue dune formation and generate very low relief dunes (cf. Bristow, 1993a); preservation of low-angle dune morphology is facilitated by dune stoss and crest erosion, during high flow-stage, and deposition of eroded sediment in the dune's trough (Hendershot *et al.*, 2016). The relative shallow channel conditions also imply waning flow, aggradation of 3D mesoforms and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); similar conditions would account for the deposition of the upper facies relating to Sl-hhs <1.0 m and Sl-hss <1.0 m. The base of facies Stsx <1.5 m forms a fifth-order bounding surface (cf. Miall, 2010b) and likely represents a chute channel generated as a result of falling-stage flow and bar top incision, due to overflow from the main channel as the flow rate subsided (Fig. 4.4B) (cf. Bristow, 1987, 1993; Ashworth et al., 2011). Subsequent deposition of facies Sl-hpx <2.0 m implies continued south-easterly downstream migration, increase in net sediment input and channel depth facilitated by flood events and deposition of medium-scale 2D mesoforms during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Further, Calamites remnants imply rapid deposition which facilitated fossil preservation; if propagated locally *Calamites* vegetation would have promoted channel bank and/or channel bar stability.

Fig. 4.5 Location 8 - Gill House Crags
Metrics Plot and Palaeocurrent Azimuths

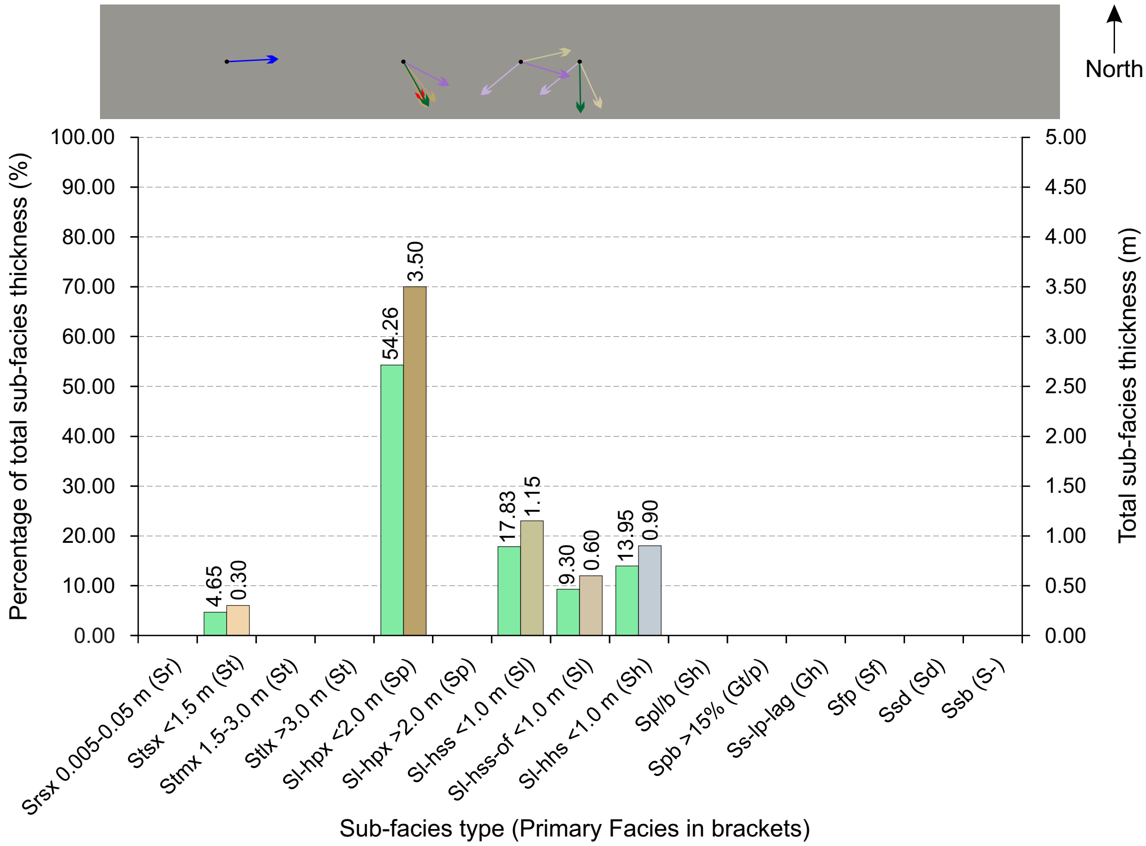


Fig. 4.6 Location 8 - Gill House Crags
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

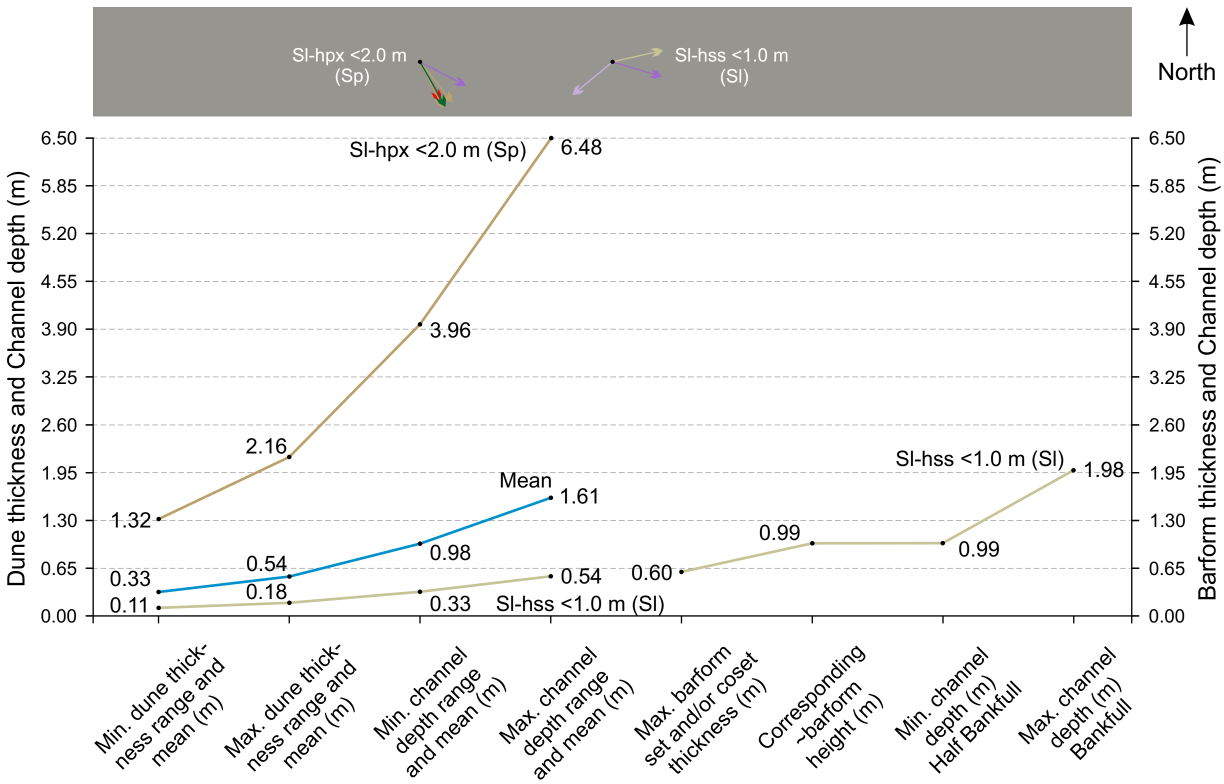
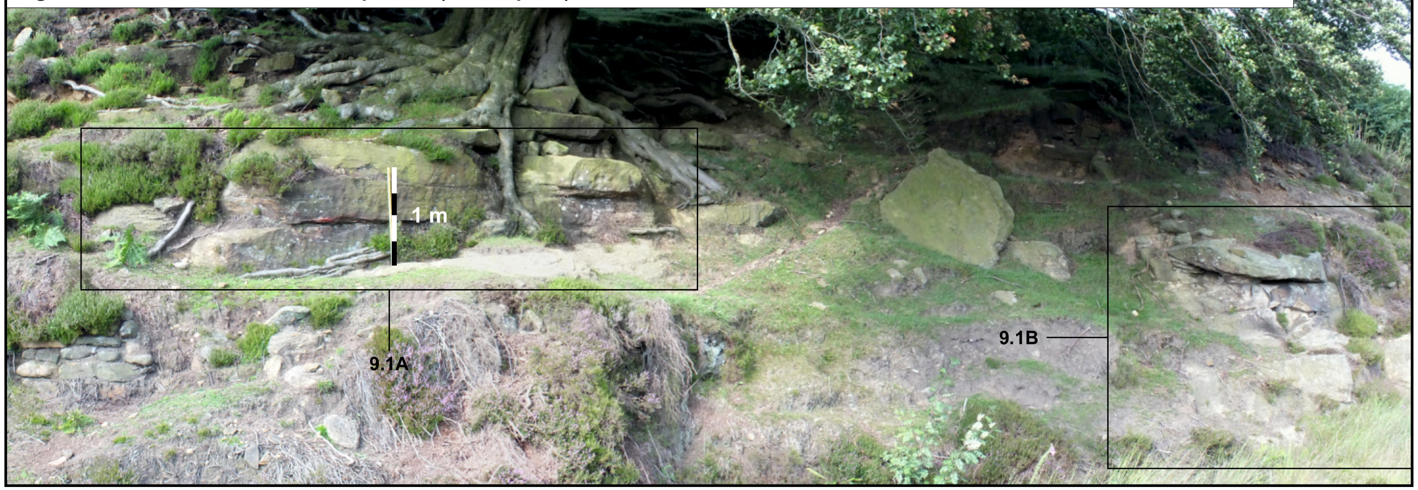
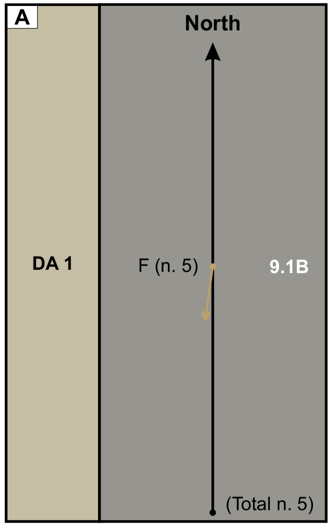
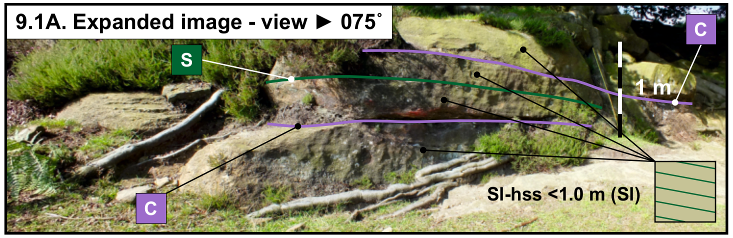


Fig. 4.4 Location 9 - Green Sike exposure (Outcrop 9.1) - Grid ref: SE 13166 57739 - Elevation: ~250 m O.D. - Main view ► 360˚

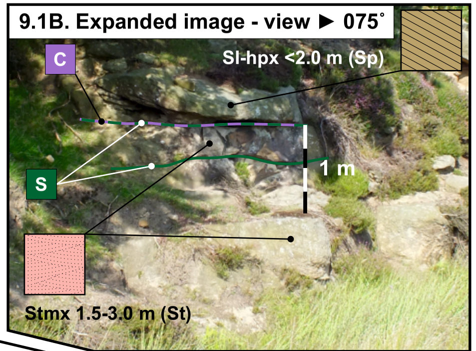




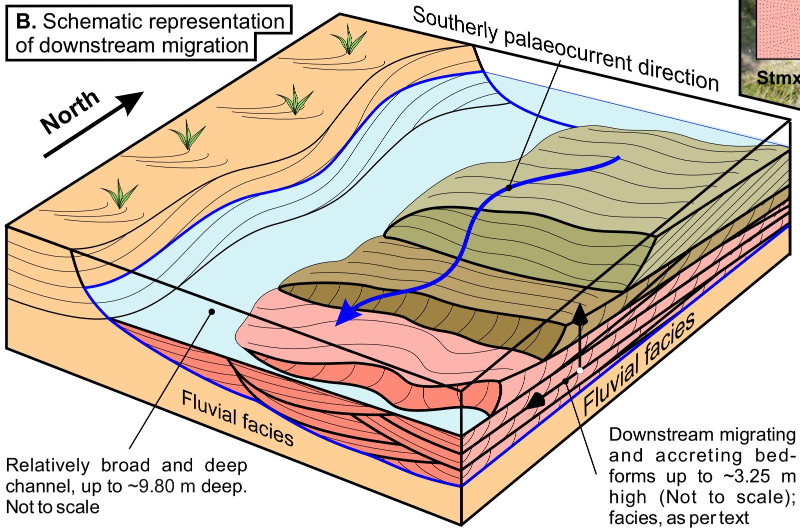
9.1A. Expanded image - view ► 075˚



9.1B. Expanded image - view ► 075˚



B. Schematic representation of downstream migration



Interpretation: (Outcrop 9.1) Limited palaeocurrent data suggests bedform migration and subsequent accretion was influenced by southerly palaeocurrents (Fig. 4.4A). Variable set thicknesses of between 0.10 m (facies Sl-hss <1.0 m) and 0.90 m (facies Stmx 1.5-3.0 m) implies a maximum dune height and channel depth of ~3.25 m and 9.80 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~0.50 m (facies Sl-hss <1.0 m) equates to a maximum dune/bar height and channel depth of ~0.90 m and 1.80 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). The relative bedform size relating to facies Stmx 1.5-3.0 m and Sl-hpx <2.0 m, imply a temporal variation in palaeo-discharge and rate of dune migration and accumulation, probably facilitated by repeated flood events (cf. Coleman, 1969; Bristow, 1987, 1993; Ashworth *et al.*, 2011), as large sandy bedforms are indicative of flood events (cf. Cant & Walker, 1978; Ashworth *et al.*, 2011; Reesink *et al.*, 2014) and deep channels generally possess larger dune bedforms (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Hence, such facies were likely deposited along a channel base, rather than host barforms (Fig. 4.4B) (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Facies Sl-hss <1.0 m likely represent migratory bedforms that developed in a shallow channel (cf. Ashworth *et al.*, 2011), possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976). Cosets of facies Sl-hss <1.0 m may also represent: i. downstream migration and aggradation of small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); ii. latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014) influenced by high-flow stage, which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); iii. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006), i.e. sets divided by first-order boundaries representing repeated bedform migration as a train of dunes (dune stacking); or, iv. components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). Preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982).

Fig. 4.5 Location 9 - Green Sike Stream
Metrics Plot and Palaeocurrent Azimuths

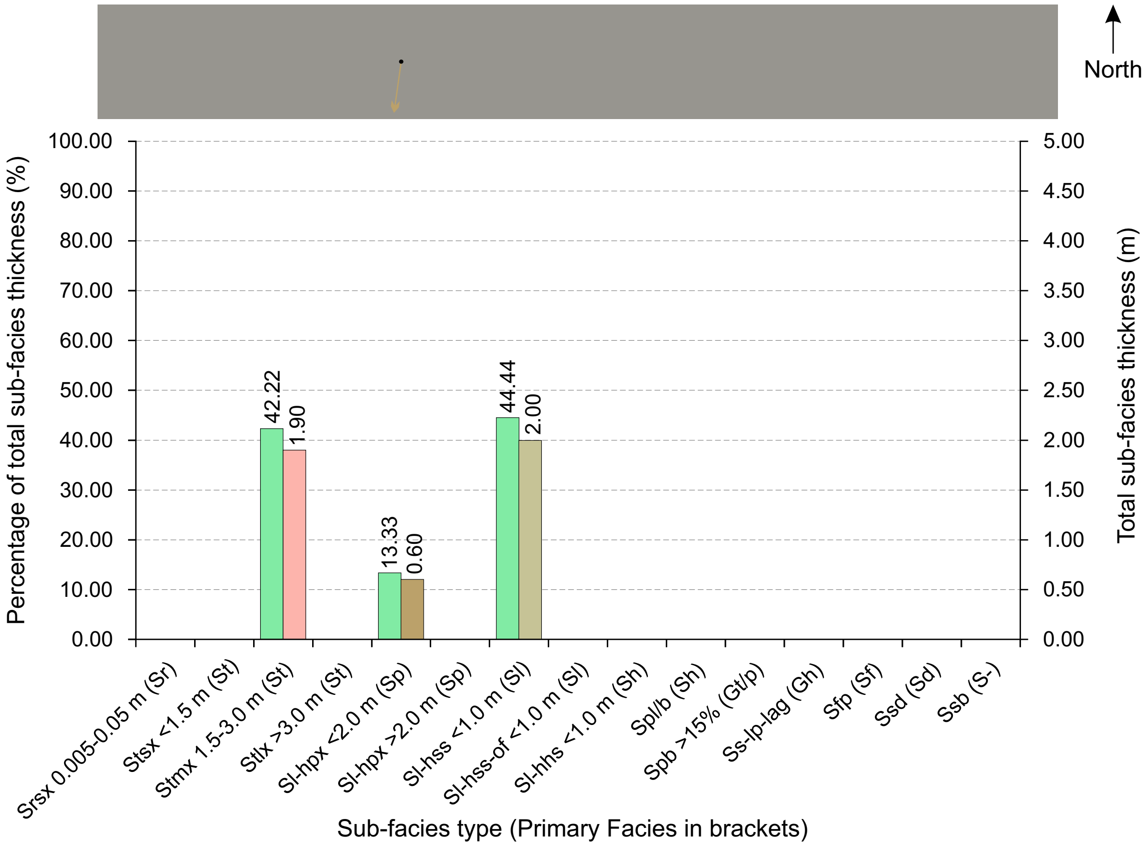


Fig. 4.6 Location 9 - Green Sike Stream
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

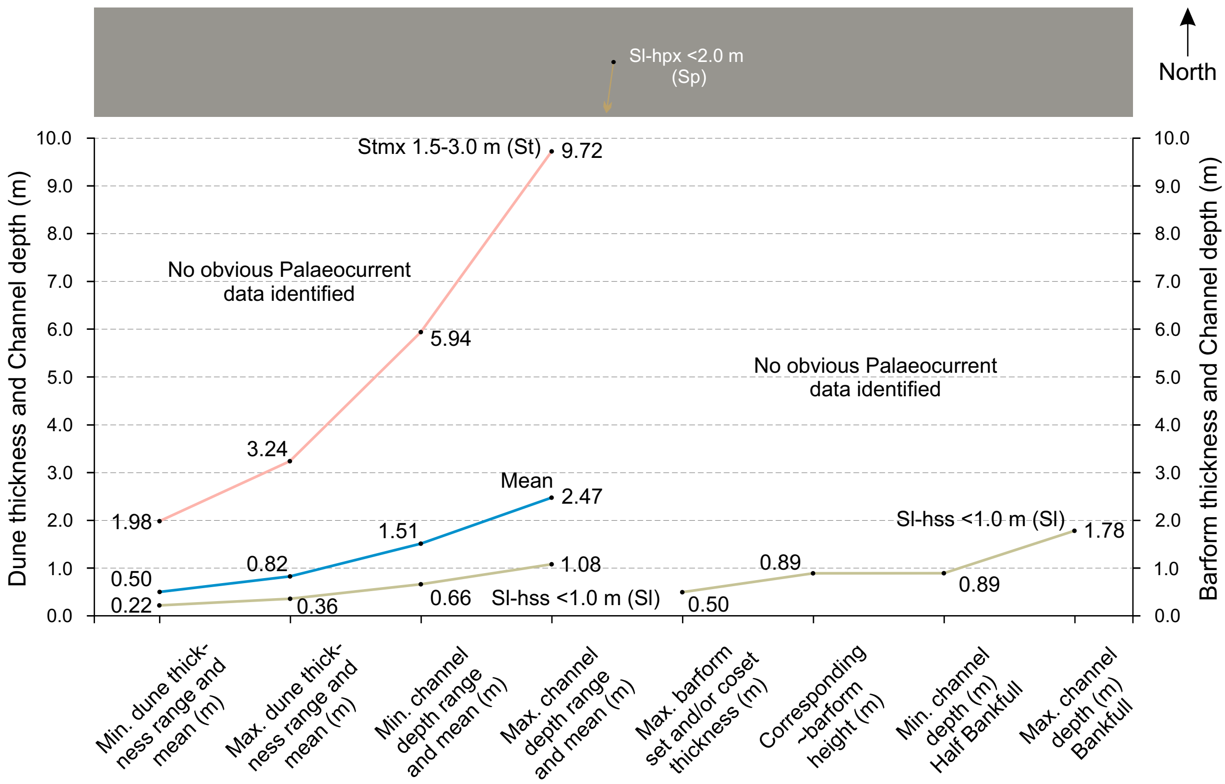
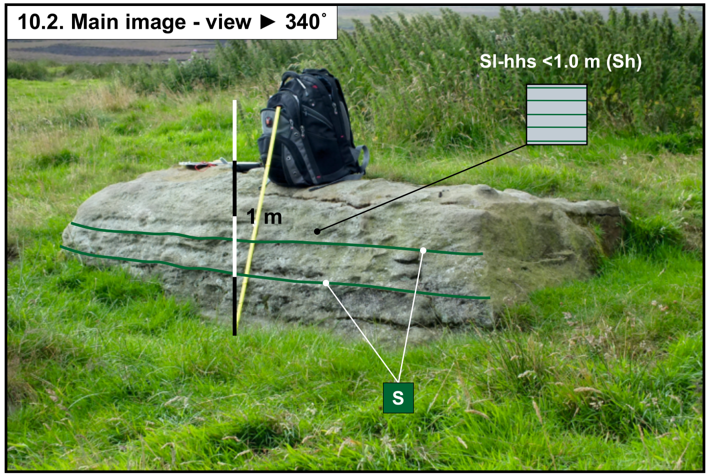
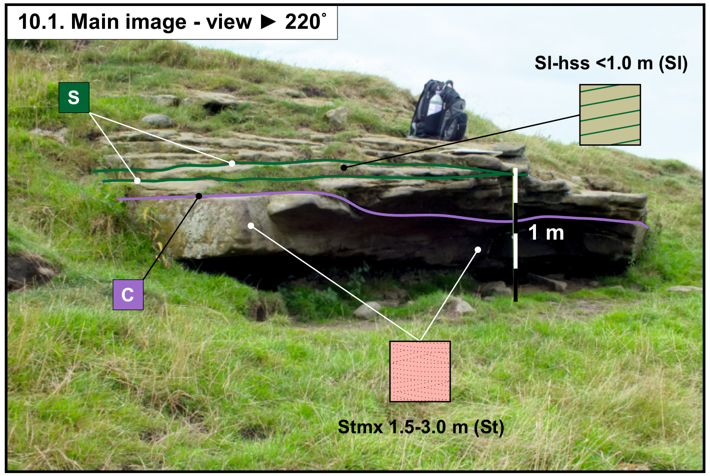


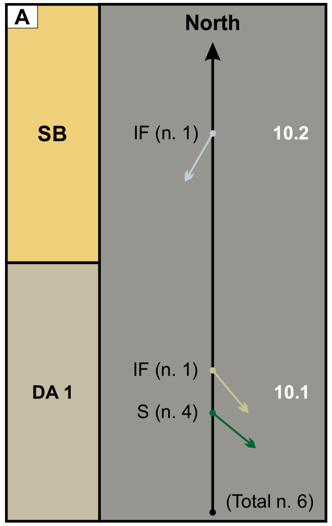
Fig. 4.4 Location 10 - Peat Hill (Outcrops 10.1-10.2) - Grid ref's: SE 13793 57882 - SE 13718 57858 - Elevation: ~260 m - 263 m O.D.

10.2. Main image - view ▶ 340˚

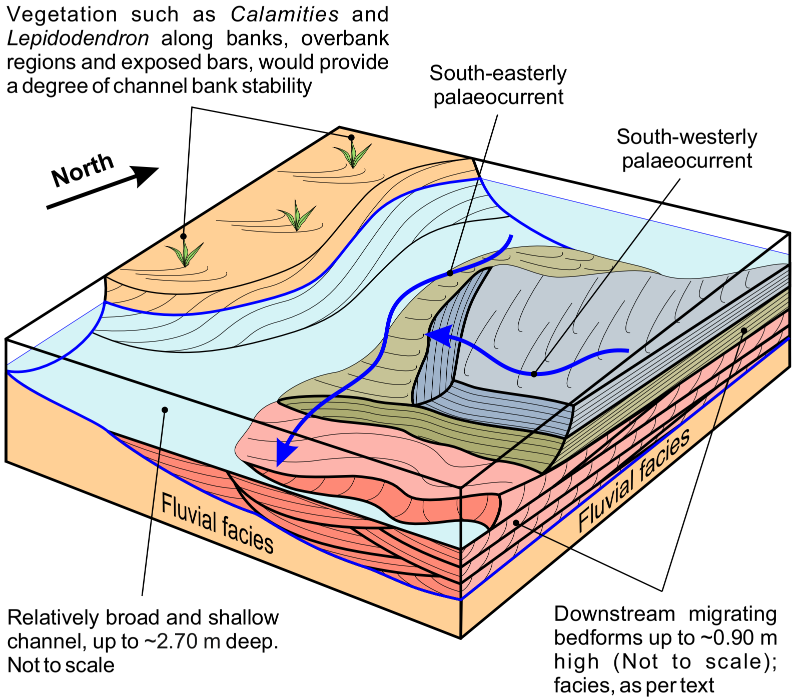


10.1. Main image - view ▶ 220˚





B. Schematic representation of bedform and palaeocurrent readjustment



Interpretation: Although limited and in parts inferred, the palaeocurrent data suggests variable bedform migration and sediment accretion influenced by initial south-easterly (Outcrop 10.1) and subsequent south-westerly (Outcrop 10.2) palaeocurrents (Fig. 4.4A). Variable set thicknesses of between 0.10 m (facies Sl-hss <1.0 m and Sl-hhs <1.0 m) and 0.25 m (facies Stmx 1.5-3.0 m) implies a maximum dune height and channel depth of ~0.90 m and 2.70 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~0.50 m (facies Sl-hss <1.0 m) equates to a maximum dune/bar height and channel depth of ~0.75 m and 1.50 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6).

Outcrop 10.1: The facies association suggest that initially the fluvial channel supported relatively large bedform (Stmx 1.5-3.0 m) migration and accumulation, probably facilitated by flood events (cf. Coleman, 1969; Bristow, 1987, 1993; Ashworth *et al.*, 2011). Conversely, the ensuing facies of Sl-hss <1.0 m implies readjustment to relatively shallow channel conditions associated with waning flow, aggradation of 3D mesoforms and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such bedforms are also associated with high-flow stage which facilitated the formation and downstream migration of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011). Outcrop 10.2: The shallow channel conditions associated with facies Sl-hhs <1.0 m (~1.10 m deep; cf. Reesink & Bridge, 2009; Leclair, 2011) implies waning flow, aggradation of 3D mesoforms and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014) and readjustment towards a south-westerly palaeocurrent (Fig. 4.4B). Such bedforms are also associated with a series of distinct depositional episodes (cf. Collinson *et al.*, 2006) of assembled sets divided by first-order set boundaries, which indicate repeated bedform migration probably as a train of dunes (dune stacking) that may have formed components of a larger bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Miall, 2010b; Ashworth *et al.*, 2011), or larger sand flat (cf. Cant & Walker, 1976, 1978).

Shallow inclined (≤10°) first-order bounding surface dips (Outcrop 10.1) may correspond to channels possessing high width to depth ratios (Bristow, 1993a) and down-climbing dunes may represent small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009). The relatively coarse-grained to granular sandstone texture coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003).

Fig. 4.5 Location 10 - Peat Hill
Metrics Plot and Palaeocurrent Azimuthsl

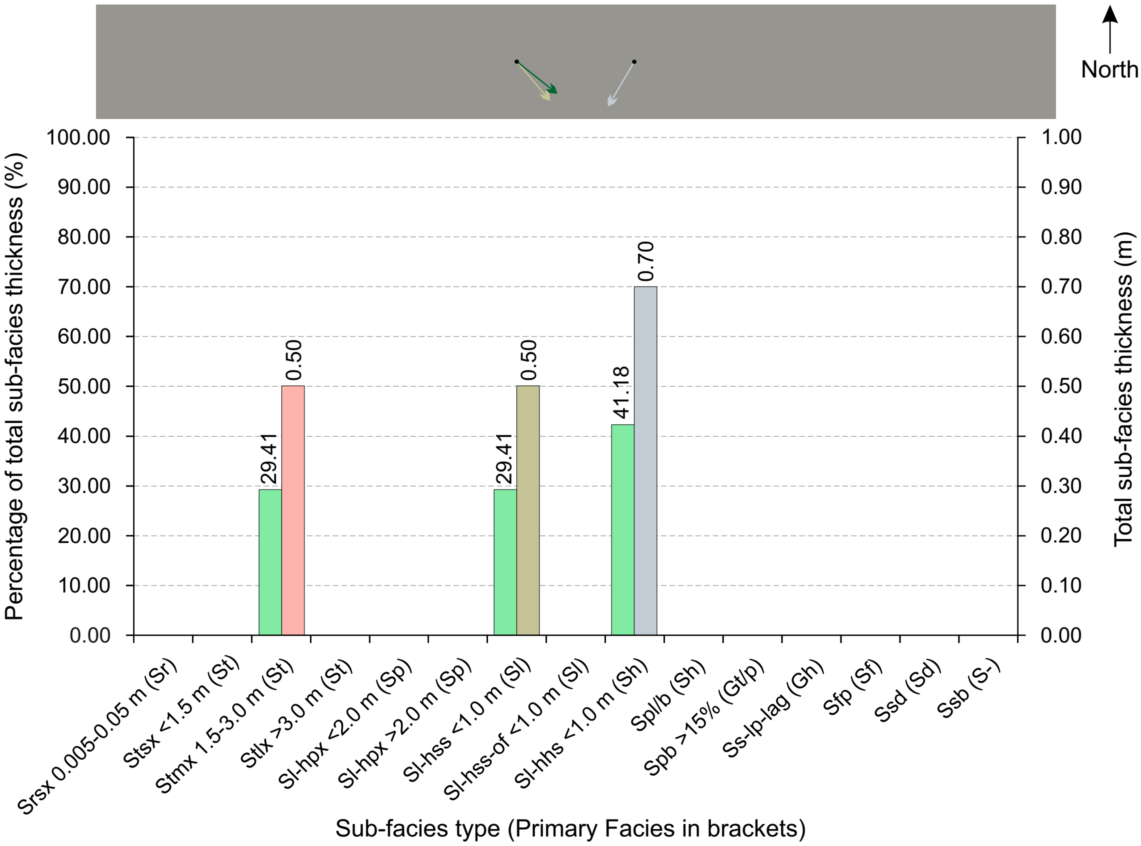


Fig. 4.6 Location 10 - Peat Hill
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

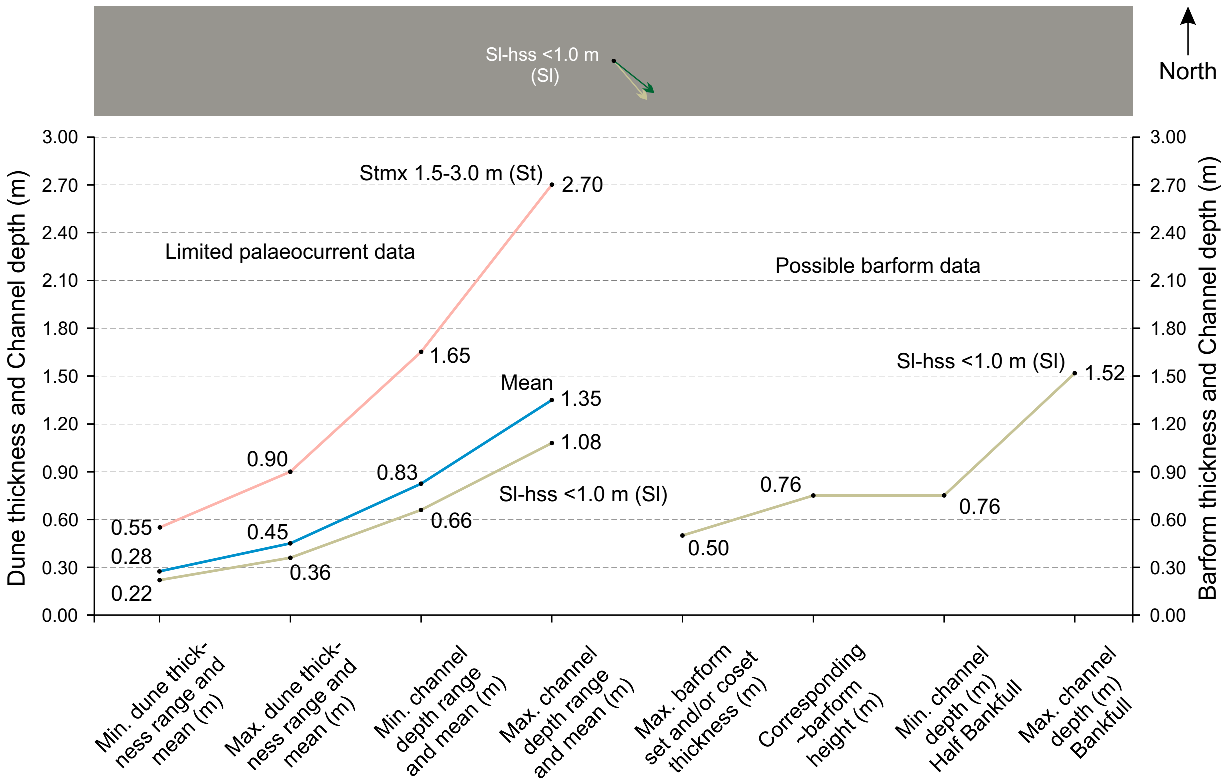
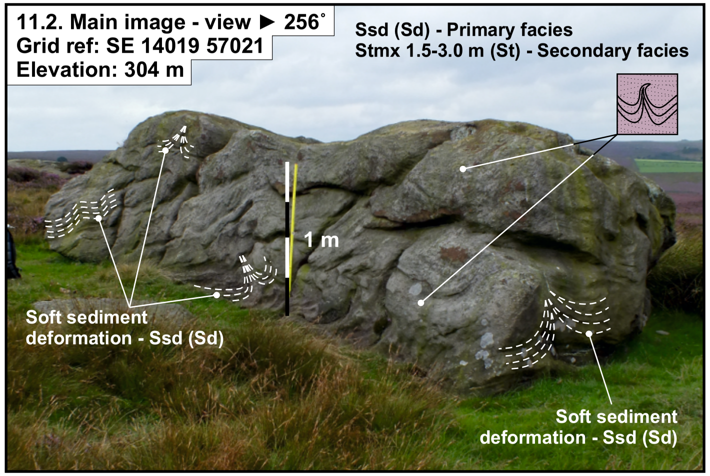
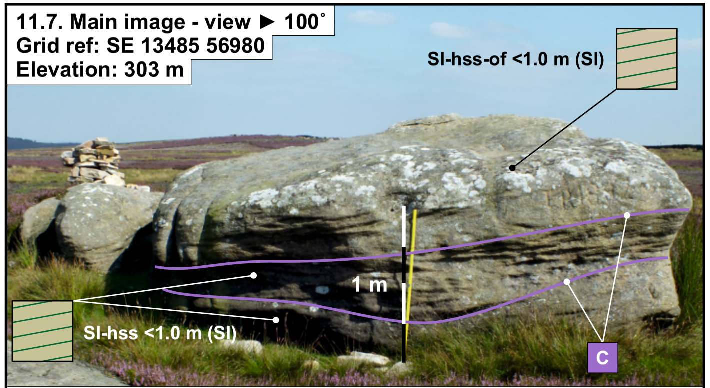
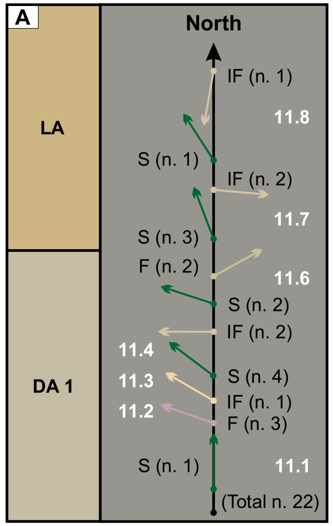


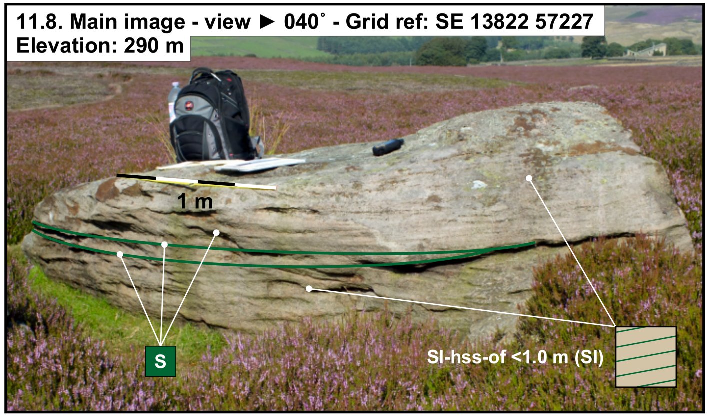
Fig. 4.4 Location 11 - Hard Pits (Outcrops 11.1-11.8) - Grid ref's: SE 14049 57050 - SE 13822 57227 - Elevation: ~300 m - 290 m O.D.





Outcrops not illustrated: 11.1, 11.3, 11.4, 11.5 and 11.6 - Grid ref's: SE 14049 57050, SE 13994 57013, SE 13881 56969, SE 13443 56962 and SE 13410 56950 - Elevation: ~300, 304, 304, 302 and 302 m O.D.





Interpretation: Although limited and in parts inferred, palaeocurrent set data (Outcrops 11.1-11.8) vary between westerly and northerly flow directions; similarly, foreset data are more varied with flow directions towards the west, east and south (Fig. 4.4A). Such palaeocurrent data imply that deposition may have been influenced by lateral-accretion and/or dune-scale bedform migration obliquely over, around and down a curved barform front/tail (cf. Haszeldine, 1983b). Variable set thicknesses of between 0.10 m (e.g. facies Sl-hss <1.0 m and Sl-hss-of <1.0 m) and 0.70 m (facies Stmx 1.5-3.0 m) imply a maximum dune height and channel depth of ~2.50 m and 7.55 m, respectively (Fig. 4.6) (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b); a coset thickness of ~0.60 m (facies Sl-hss <1.0 m) equates to a maximum dune/bar height and channel depth of ~0.85 m and 1.70 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011). Generally, Outcrops 11.1-11.8 represent intermittent components of a multi-channel braided fluvial system (cf. Reesink *et al.*, 2014), i.e. a minimum of two second-order channels partitioned by mid-channel bars (cf. Bristow, 1987). Outcrops 11.5-11.7 posses coarser sediments and larger bedforms, implying stronger palaeocurrents and deeper channels, respectively; channel bedforms are represented by Outcrops 11.2-11.3 and 11.5. The relative set thicknesses of the facies associated Outcrops11.2-11.3 (e.g. Stmx 1.5-3.0 m, ~0.70 m thick) suggest deposition was towards the channel thalweg/axis where large dunes tend to develop; the size of cross-bedding also implies downstream-accretion within a relatively broad and deep channel (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Similarly, the ~1.00 m thick sets relating to Outcrop 11.5 implies downstream migration and aggradation of a unit bar (3D mesoform) (cf. Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006); a 1.00 m thick set equates to a maximum barform height and channel depth of ~3.00 m and ~6.00 m, respectively (Fig. 4.6) (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014). Outcrops 11.1 and 11.4 likely represent downstream and lateral-accretion components of mid-channel bars, the components of which possibly consist of bar top, margin or tail facies e.g. Sl-hss <1.0 m and Sl-hss-of <1.0 m. The relative set thickness of ~0.10 m suggest a maximum dune height and channel depth of ~0.35 m and ~1.10 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). Facies Sl-hss <1.0 m may represent migratory bedforms that developed in a shallow channel (cf. Ashworth *et al.*, 2011), possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976). Cosets of facies Sl-hss <1.0 m may also represent: i. downstream migration and aggradation of small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); ii. latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014) influenced by high-flow stage, which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011); iii. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006), i.e. sets divided by first-order boundaries representing repeated bedform migration as a train of dunes (dune stacking); or, iv. components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). Preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). During falling-flow stage conditions, mid-channel bars may control channel flow patterns as they become increasingly exposed and gradually divide and divert the main channel flow around bar margins (Collinson, 1970, 1996; cf. Reesink *et al.*, 2014). Topographic lows adjacent to bar margins may limit falling-stage currents that flow between bars (Collinson, 1970; cf. Reesink *et al.*, 2014), thereby facilitating lateral-accretion by promoting deposition along bar margins (Collinson, 1970, 1996). Further, palaeocurrent facies data relating to Sl-hss <1.0 m and Sl-hss-of <1.0 m (Outcrops 11.6-11.8, respectively) imply bar top vertical and/or upstream-accretion associated with the bar head and/or mid-bar section of a mid-channel bar, primarily due to dune stacking and shallow flow depth above the host bar (cf. Best *et al.,* 2003; Bridge & Lunt, 2006; Mumpy et al., 2007).

Fig. 4.5 Location 11 - Hard Pits
Metrics Plot and Palaeocurrent Azimuths

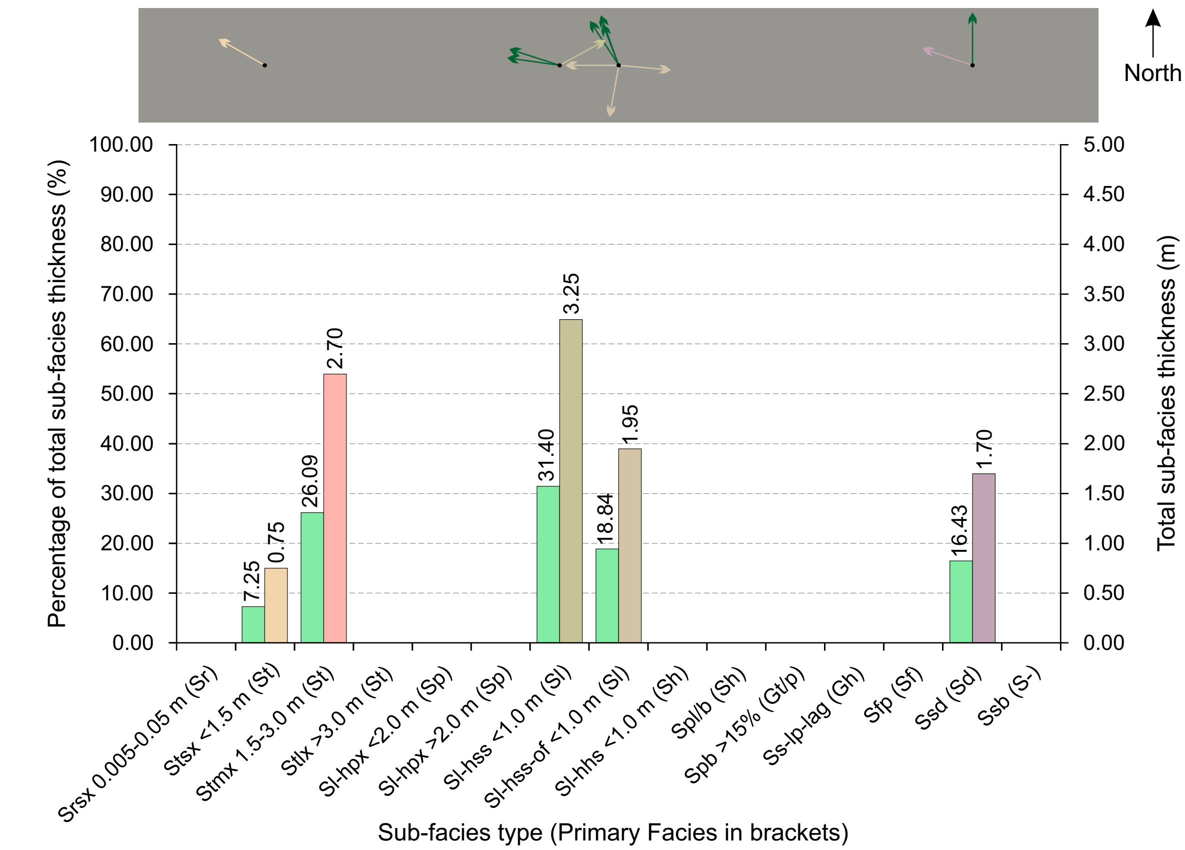


Fig. 4.6 Location 11 - Hard Pits
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

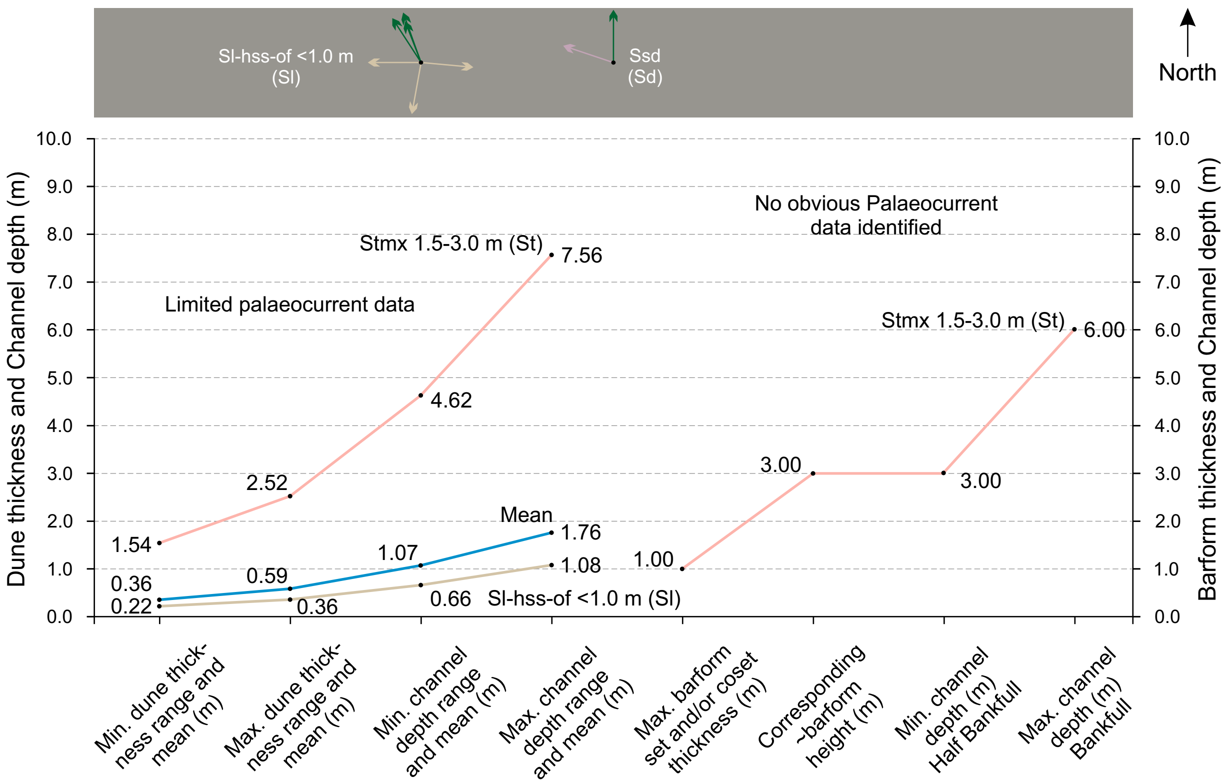
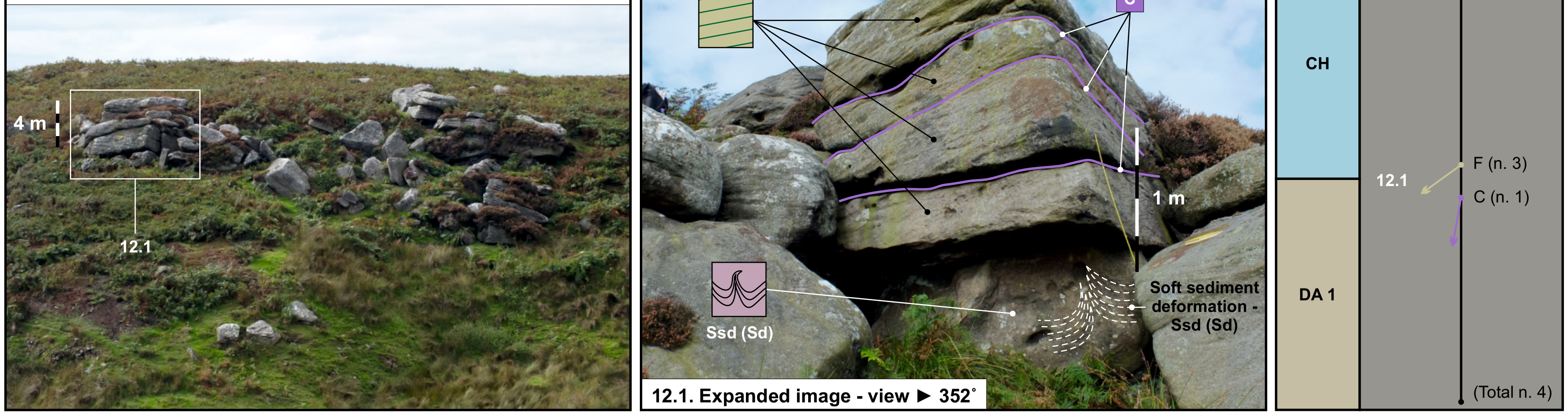
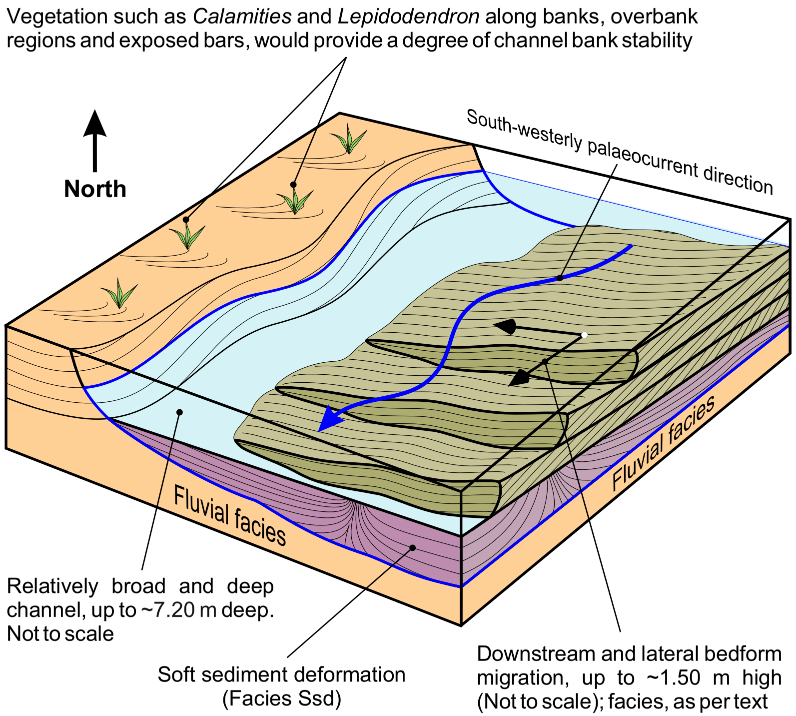


Fig. 4.4 Location 12 - Foulshaw Crags (Outcrop 12.1) - Grid ref: SE 14832 62690 - Elevation: ~310 m O.D. - Main view ► 276˚



B. Schematic representation of downstream and lateral bedform migration



Interpretation: (Outcrop 12.1) Limited palaeocurrent data suggests bedform migration and accretion was influenced by south-westerly palaeocurrents (Fig. 4.4A). Variable set thicknesses of between 0.10 and 1.20 m (facies Sl-hss <1.0 m and Ssd) implies a maximum bar height and channel depth of ~3.60 m and 7.20 m, respectively (Fig. 4.6) (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b), therefore, given that bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a coset thickness of ~1.00 m (facies Sl-hss <1.0 m) equates to a maximum bar height and channel depth of ~1.50 m and 3.00 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011). Soft sediment deformation (liquefaction) at the base of the outcrop implies influence of water saturation and event(s) that triggered de-watering processes, for example sudden overburden post flood event and/or syn-sedimentary tectonic activity post deposition. Evidence suggesting a sudden overburden was the triggering event is not evident, due to the relatively small-scale overlying sets; therefore, although overburden cannot be totally discounted, tectonic activity may have played a more significant role. The overlying cosets of facies Sl-hss <1.0 m, bounded by third and second-order bounding surfaces, may represent migratory mid-channel bar bedform components (cf. Reesink & Bridge, 2009) that likely formed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014) and/or small-scale downstream migrating unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009), which in turn likely form components of a much larger host compound bar (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011), although such component coset/unit bar heights coincide with dune heights (Ashworth *et al.*, 2011). The sub-horizontal second-order coset bounding surface contacts are likely third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014). Such contacts denote a component of lateral coset (mesoform) accretion and growth of the host compound bar (macroform) through lateral and downstream-accretion (Fig. 4.4B) (cf. Bridge & Lunt, 2006). The individual sub-horizontal sets, and variable set thicknesses of between 0.10-0.20 m, imply varying amounts of sediment input likely influenced by a fluctuating flow stages which facilitated the formation of down-climbing dunes and downstream migration (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011), probably influenced by periodic rise and fall in flow rate facilitated by flood events. Bedform deposition also implies waning flow, net mesoform aggradation channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition, most sets will climb relative to the angle/dip of their host bed (Leeder, 1982).

Fig. 4.5 Location 12 - Foulshaw Crags
Metrics Plot and Palaeocurrent Azimuths

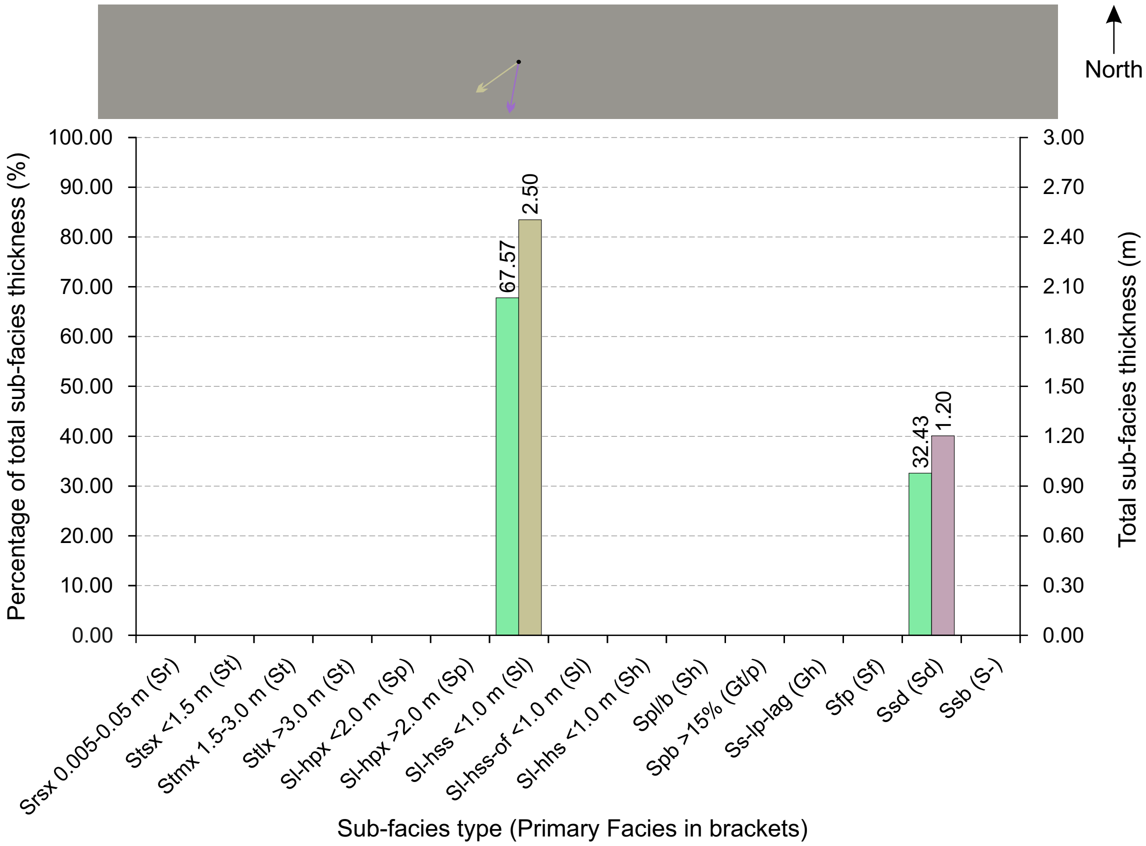


Fig. 4.6 Location 12 - Foulshaw Crags
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

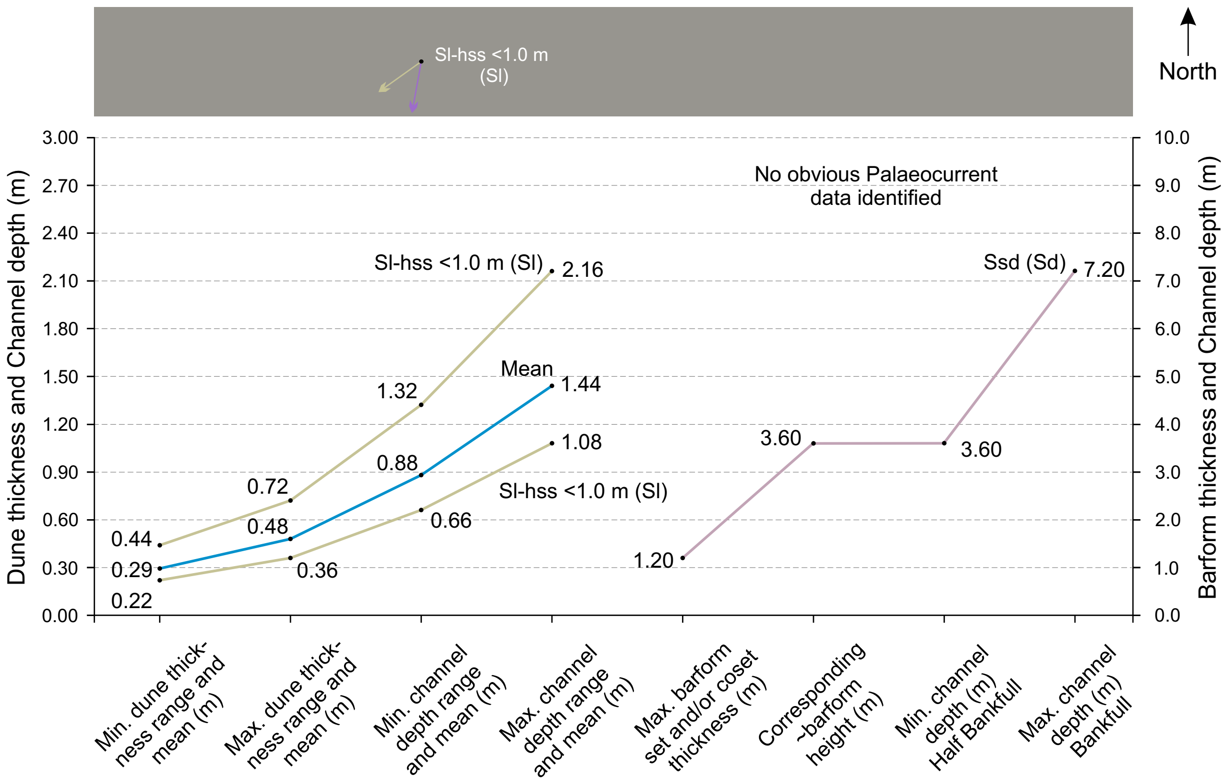
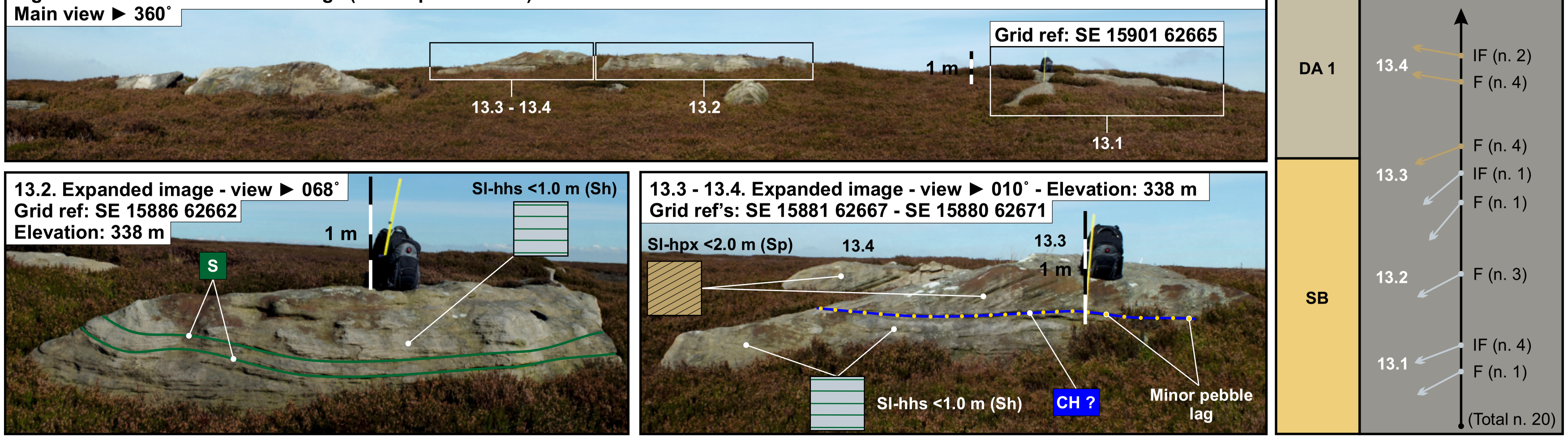
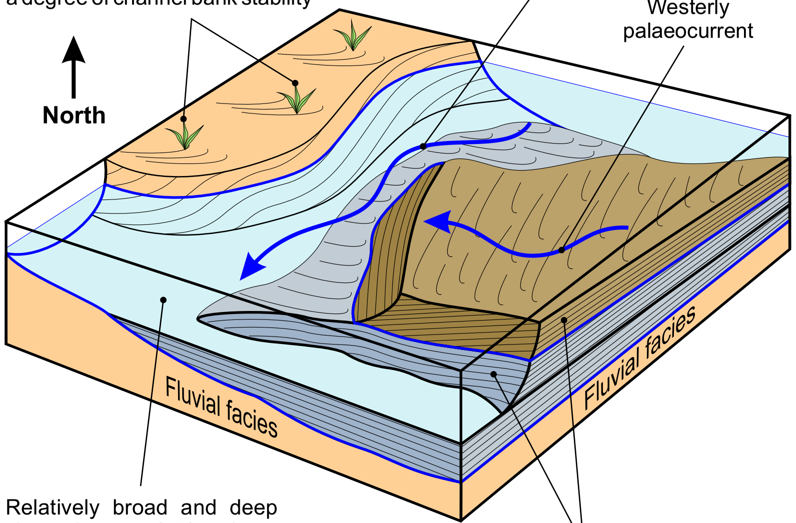


Fig. 4.4 Location 13 - Old Wife Ridge (Outcrops 13.1-13.4) - Grid ref's: SE 15901 62665 - SE 15880 62671 - Elevation: ~338 m O.D.



B. Schematic representation of thalweg and bedform migration



Interpretation: (Outcrop 13.1-13.4; 13.1 not illustrated) Limited palaeocurrent data suggests bedform migration and accretion influenced by south-westerly (facies Sl-hhs <1.0 m) and westerly (facies Sl-hpx <2.0 m) palaeocurrents (Fig. 4.4A). Variable set thicknesses of 0.10 to 0.70 m (facies Sl-hhs <1.0 m and Sl-hpx <2.0 m, respectively) imply a maximum dune height and channel depth of ~2.50 m and 7.55 m, respectively (Fig. 4.6) (cf. Leclair, 2011). The initial set thicknesses associated with facies Sl-hhs <1.0 m (0.10-0.15 m) imply the host channel was relatively shallow (~1.10-1.60 m deep) (cf. Reesink & Bridge, 2009; Leclair, 2011). Such facies may represent downstream migration and net mesoform accretion within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink *et al.*, 2014), influenced by waning flow, net sediment aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth et al., 2011; Reesink *et al.*, 2014). Such facies may also represent: i. migratory bedforms that developed on the surface of a larger sand flat (cf. Cant & Walker, 1976); ii. the latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014); and/or iii. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006) of assembled sets divided by first-order set boundaries indicating repeated bedform migration, probably as a train of dunes (dune stacking) which may have formed components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). Similarly, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition, most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). In contrast, facies Sl-hpx <2.0 m implies the host channel was much deeper (~5.60-7.60 m deep), evidenced by the 0.50-0.70 m thick sets (cf. Reesink & Bridge, 2009; Leclair, 2011). Flood events and their associated high and low-flow stages would have influenced dune migration and net deposition during waning flow, respectively (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Such flood events may have also influenced thalweg migration and alterations in flow direction, as indicated in the palaeocurrent data (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). Hence, Outcrops 13.1-13.4 are likely associated with the downstream migration and net aggradation of relatively small scale dunes and subsequent lateral bedform migration influenced by a flood event that facilitated a minor change in thalweg and/or bedform direction and therefore channel migration (Fig. 4.4B). The minor lag deposit at the base of facies Sl-hpx <2.0 m may represent: i. a basal flood deposit (part of) and high-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011); ii. the location of a channel thalweg/axial region (Fidolini *et al.*, 2013; Ghinassi *et al.*, 2014) where relatively larger bedforms develop (Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); iii. localised scouring (Miall, 2010b); and/or iv. winnowing (cf. Collinson *et al.*, 2006) processes.

Fig. 4.5 Location 13 - Old Wife Ridge (Heyshaw Moor)
Metrics Plot and Palaeocurrent Azimuths

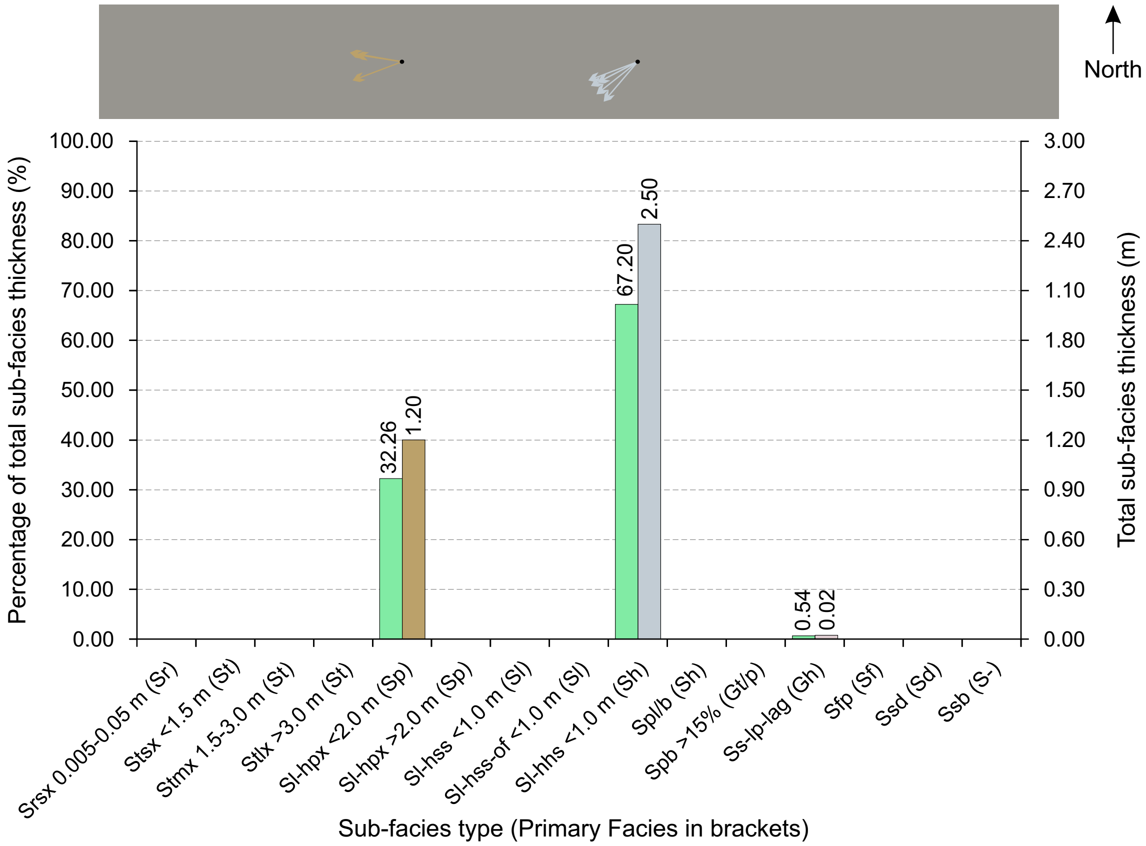


Fig. 4.6 Location 13 - Old Wife Ridge (Heyshaw Moor)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

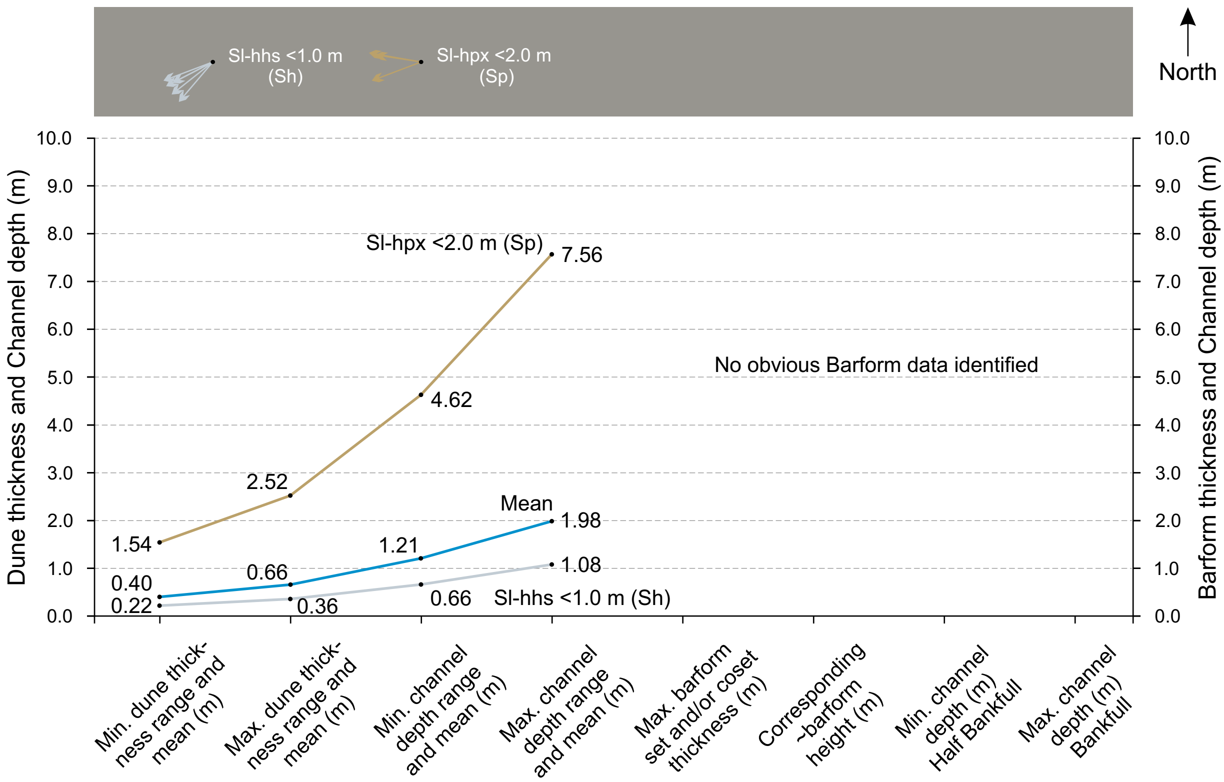
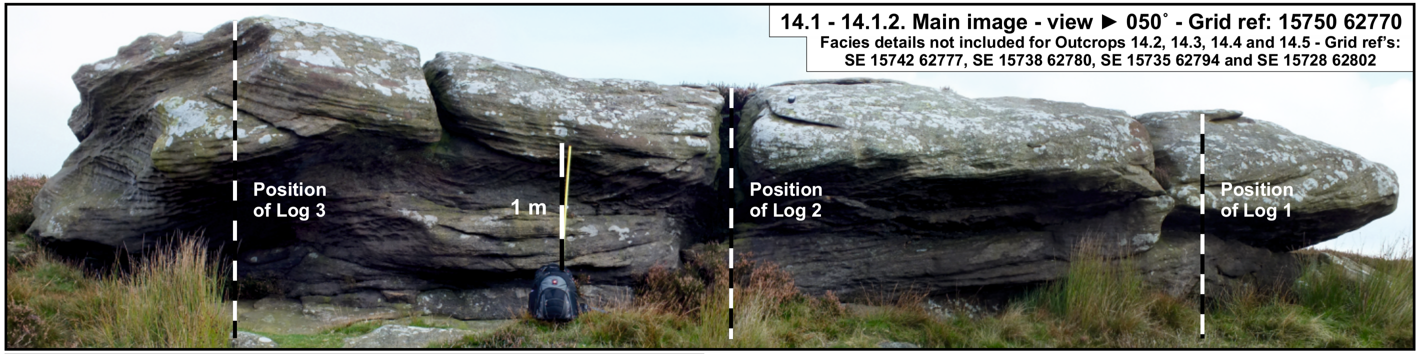
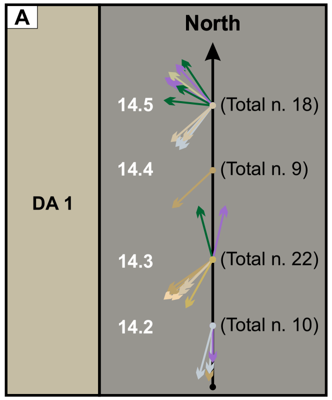
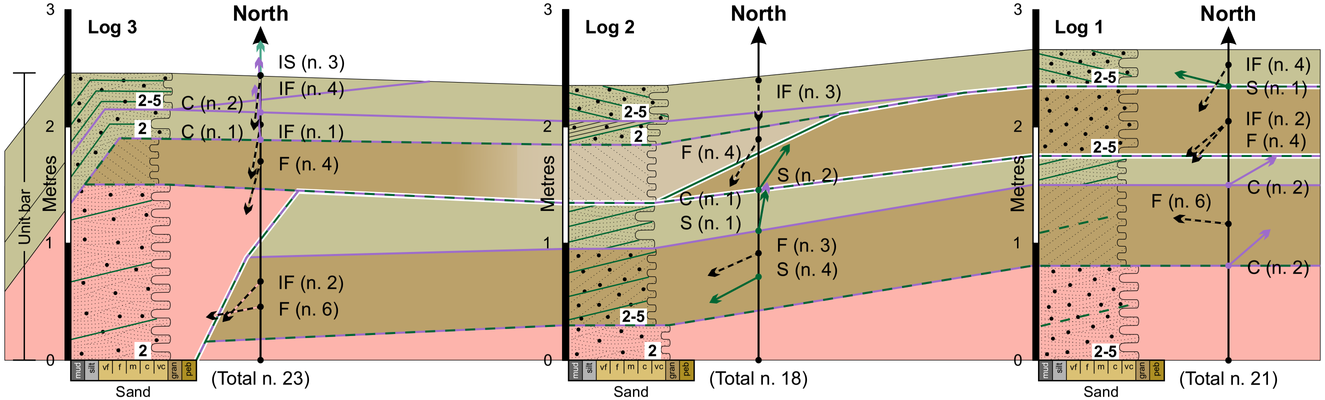


Fig. 4.4 Location 14 - Flat Crags (Outcrops 14.1-14.5) - Grid ref's: SE 15750 62770 - SE 15728 62802 - Elevation: ~333 m O.D.





B. Fence diagram depicting unit bar/dune components of a compound bar (Part of)



Interpretation: (Outcrops 14.1-14.1.2) Generally, foreset palaeocurrent data implies that, as you move up the sequence, the depositional current varies from a westerly to southerly direction; in contrast set data varies more widely from a south-westerly to a north-easterly direction, whereas coset data varies from a north-easterly to a northerly direction (Fig. 4.4B). Variable set thicknesses of between 0.05 and 0.60 m (facies Sl-hss <1.0 m and Sl-hpx <2.0 m, respectively) implies a maximum dune height and channel depth of ~2.15 m and 6.50 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b) and/or bars, therefore, since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~2.45 m bar thickness (Log 3) equates to a maximum bar height and channel depth of ~2.60 m and 5.20 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). The 0.20–0.40 m thick basal facies relating to Stmx 1.5-3.0 m and Sl-hpx <2.0 m, respectively (Logs 1 and 2) likely represent flood events, in channel vertical-accretion (cf. Best *et al.*, 2003; Bridge & Lunt, 2006) and/or downstream-accretion within a relatively broad and deep channel with dune migration near to the thalweg/axis (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). The overlying facies of Sl-hss <1.0 m imply limited sediment input into a relatively shallow channel, likely influenced by high-flow stage which facilitated the formation of subcritical set angles, as they migrated over a slower moving or stalled host bedform (cf. Haszeldine, 1983a, 1983b; Collinson *et al.*, 2006). Together with the underlying facies, these mesoforms may form components of small-scale downstream migrating unit bar (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009). Such unit bars may form components of larger host compound bars (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011). The sub-horizontal coset/unit bar contacts are likely third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014), which denote a component of lateral coset (mesoform) accretion and growth of the host compound bar (macroform) through lateral and downstream-accretion (cf. Bridge & Lunt, 2006). The subsequent facies of Sl-hpx <2.0 m (~0.60 m thick set; Logs 1 and in part Log 2) suggests an increase in channel depth and dune or further unit bar deposition (cf. Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011) and lateral/downstream-accretion of the host compound bar; net sediment input was likely facilitated by a flood event with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Similarly, the sequence of facies relating to Log 3 and upper facies of Logs 2 and 1 (i.e. Sl-hss-of <1.0 m and Sl-hss <1.0 m) likely represent deposition of a further unit bar (Fig. 4.4B). The uppermost 0.05-0.10 m thick sets of facies Sl-hss <1.0 m probably denote initial erosion and subsequent bar top vertical and/or upstream-accretion of the bar head and/or mid-bar section of a mid-channel bar, primarily due to dune stacking and relative shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Mumpy *et al.*, 2007). The subcritical set and coset angles (facies Stmx 1.5-3.0 m and Sl-hss <1.0 m) imply that they migrated over a slower moving or stalled host bedform (cf. Haszeldine, 1983a, 1983b; Collinson *et al.*, 2006) and the relative shallow channel conditions above the host bar relating to facies Sl-hss <1.0 m imply waning flow, mesoform aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Similarly, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition, most sets will climb relative to the angle/dip of their host bed (Leeder, 1982).

Fig. 4.5 Location 14 - Flat Crags (Heyshaw Moor)
Metrics Plot and Palaeocurrent Azimuths

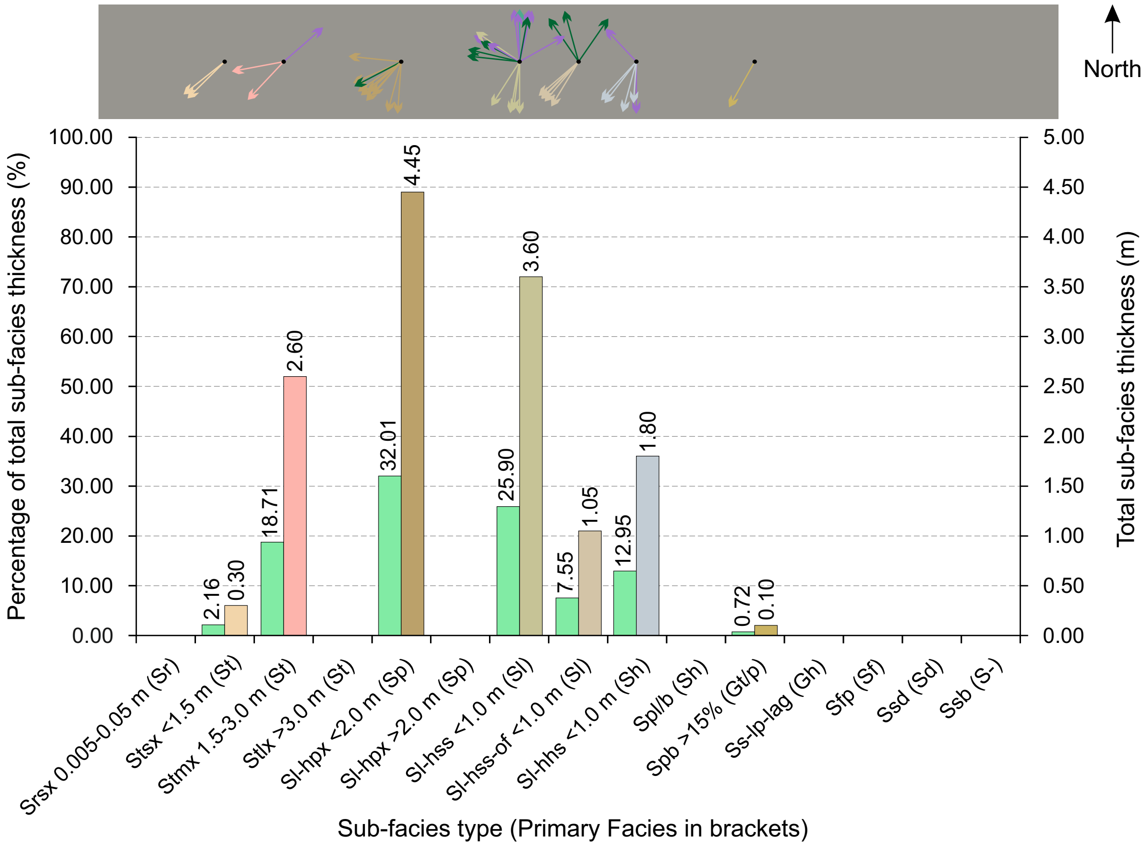


Fig. 4.6 Location 14 - Flat Crags (Heyshaw Moor)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

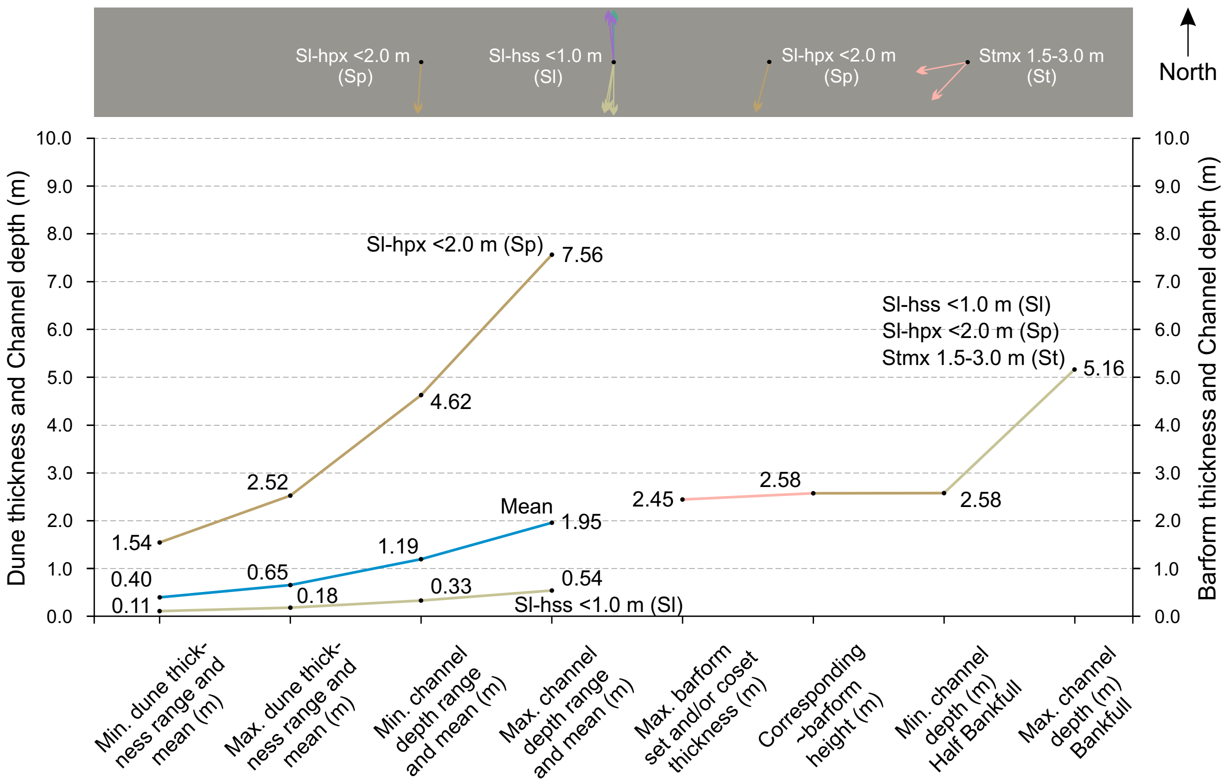
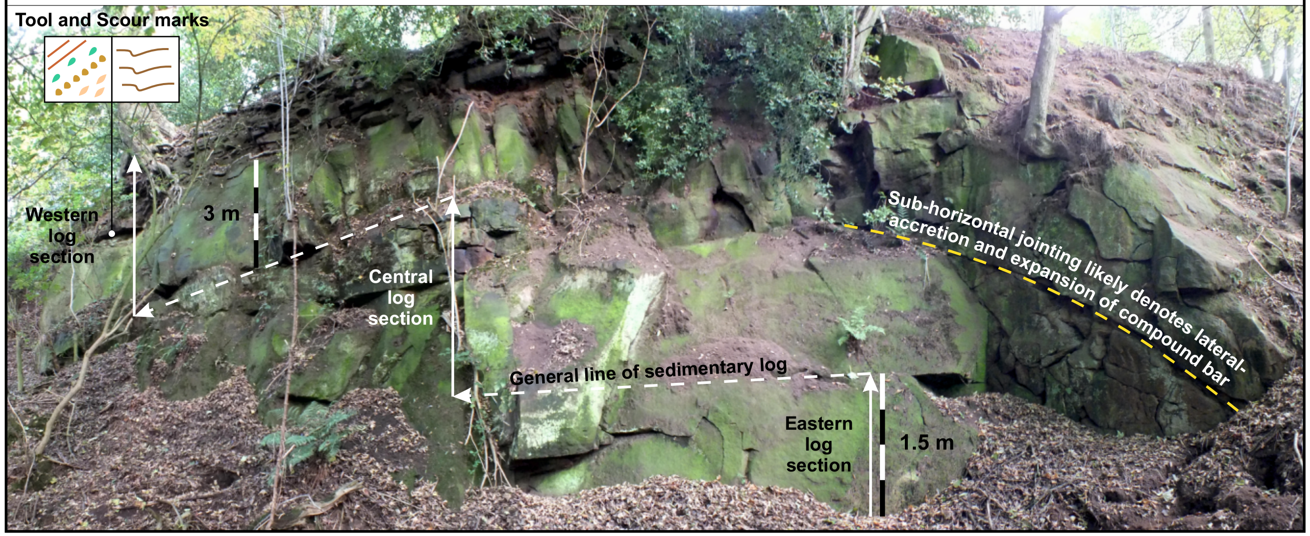
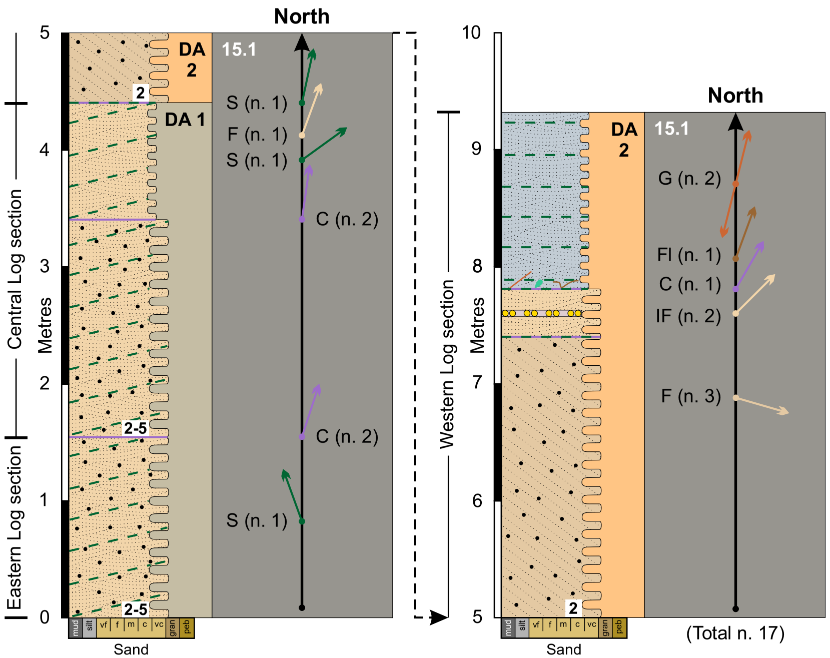


Fig. 4.4 Location 15 - High Kettle Spring Farm (Outcrop 15.1) - Grid ref: SE 26920 62414 - Elevation: ~105 m O.D. - Main view ► 030°



A. Stepped sedimentary log section through Outcrop 15.1, log stepped to facilitate access



Interpretation: (Outcrop 15.1) Limited palaeocurrent data suggests bedform migration and accretion was mainly influenced by north-easterly palaeocurrents (Fig. 4.4A). Variable set thicknesses of between 0.10 and 0.20 m (facies Sl-hhs <1.0 m) implies a maximum dune height and channel depth of ~0.70 m and 2.15 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b), therefore, given that bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a coset thickness of ~1.90 m (facies Stsx <1.5 m) equates to a maximum bar height and channel depth of ~2.40 m and 4.80 m, respectively (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011). The rounded morphology relating to the initial three cosets of facies Stsx <1.5 m may represent: i. downstream-accretion of 3D mesoforms within a relatively shallow thalweg region of a low sinuosity channel influenced by high-flow stage which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Ghinassi *et al.,* 2009; Miall, 2010b; Reesink *et al.,* 2014); ii. bar top vertical-accretion component of a channel bar, primarily due to dune stacking and relative shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006); or iii. migratory mid-channel bar bedform components; dune set components of such cosets likely formed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014) and such cosets may form individual consecutive small-scale unit bar components (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009) of a much larger compound bar (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011); similarly, individual sets may form components of larger dune cosets (cf. Haszeldine, 1983b). Further, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). The sub-horizontal coset contacts are likely third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014), which denote a component of lateral coset (mesoform) accretion and compound bar (macroform) growth, through lateral and downstream-accretion (cf. Bridge & Lunt, 2006); a reduction in bar top accommodation space may also facilitate expansion through lateral-accretion. The overlying facies of Sl-hpx >2.0 m likely represent an alternate bar (2D macroform; McCabe, 1977; Collinson, 1996; Collinson *et al.*, 2006; Miall, 2010b). The preserved ~3.00 m thick set equates to a bar height and channel depth of ~9.0 to 18.0 m, respectively (Fig. 4.6) (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014). Such facies were likely facilitated by flood events, with net deposition (aggradation) during falling-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011) reducing bar top flow depth, thereby increasing (locally) flow velocity and sediment transport (cf. Reesink & Bridge, 2009). Such conditions probably facilitated the formation of facies Stsx <1.5 m and the intervening lag deposit (facies Ss-lp-lag) which likely represents scouring (Miall, 2010b) or winnowing (cf. Collinson *et al.,* 2006) processes with no obvious evidence of a fifth-order channel surface. Similarly, facies Sl-hhs <1.0 m may represent: i. downstream migration and accretion within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.,* 2009; Miall, 2010b; Reesink *et al.,* 2014), influenced by waning flow, net sediment aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); ii. migratory bedforms that developed on the surface of a larger sand flat (cf. Cant & Walker, 1976) generated by the underlying alternate bar; and/or iii. the latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014).

Fig. 4.5 Location 15 - High Kettle Spring Farm
Metrics Plot and Palaeocurrent Azimuths

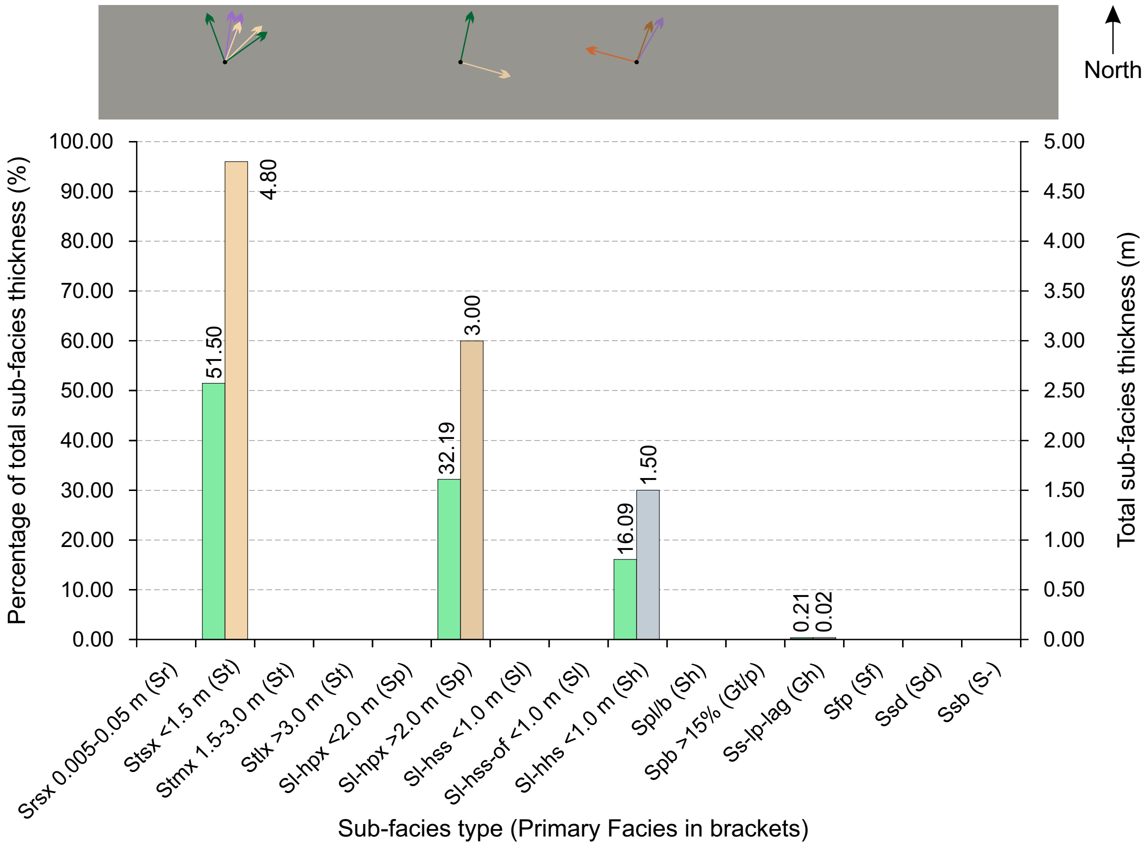


Fig. 4.6 Location 15 - High Kettle Spring Farm
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

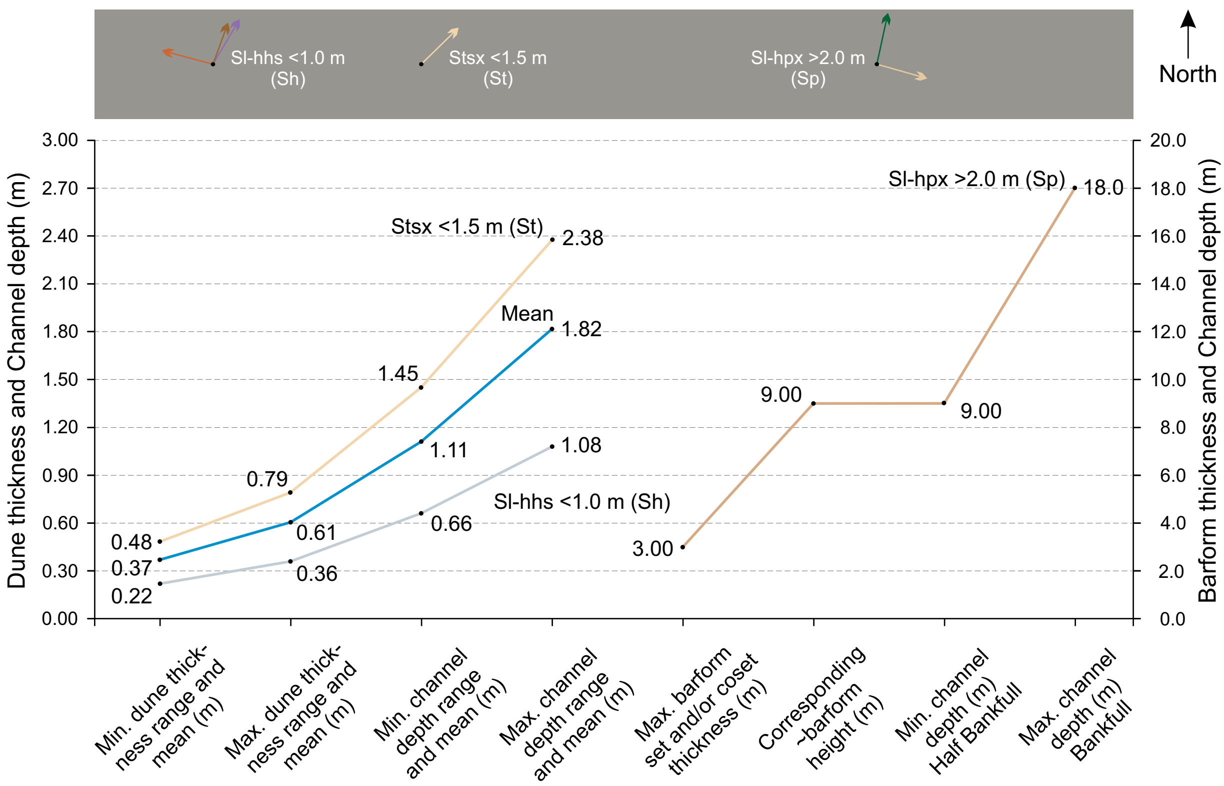
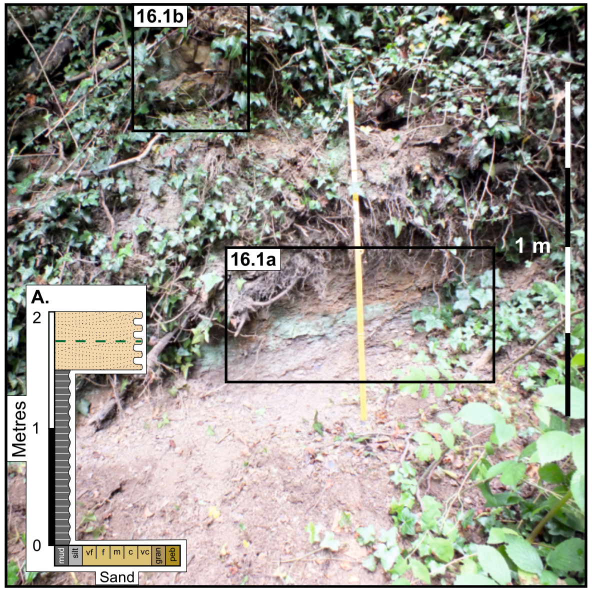
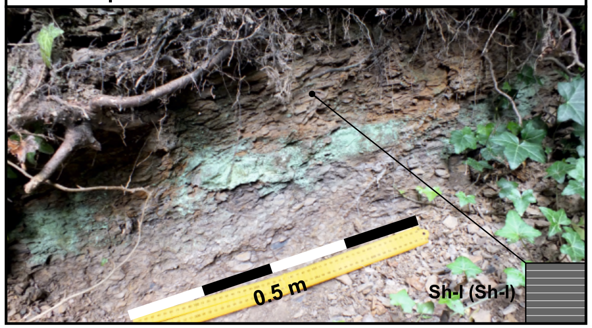


Fig. 4.4 Location 16 - High Mill - Shaw Mills (Outcrop - 16.1) Grid ref: SE 25282 62696 - Elevation: ~104 m O.D. Main view ▶ 350˚ - A. Inset depicting sedimentary log

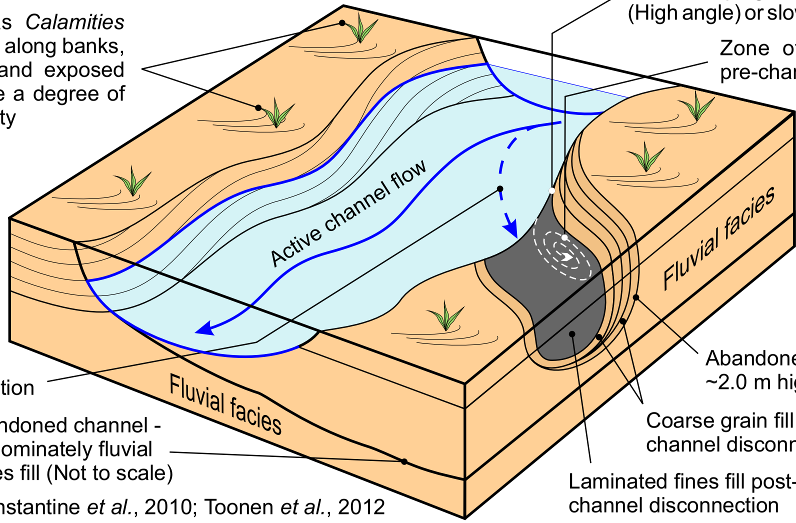


16.1a. Expanded view of facies Sh-l



16.1b. Expanded view of facies Stsx <1.5 m

B. Schematic depicting abandoned channel with coarse and fine grain fill



Modified from Constantine *et al.*, 2010; Toonen *et al.*, 2012

Interpretation: (Outcrop 16.1) No obvious palaeocurrent details observed. Thompson (1957) equates a grey shale rock within an old quarry by High Mill to the Libishaw Shales, directly overlain by the Lower Brimham Grit, thereby highlighting an erosive unconformity (Thompson, 1957; cf. Reid, 1996). Thompson (1957) describes the Libishaw Shales as a grey argillaceous shale with marine bands close to its base; these marine bands contain both lamellibranch (Bivalve) and goniatite (*Reticuloceras aff. Pulchellum*) fauna. Goniatite fauna relate to the *Reticuloceras eoreticulatum* zone (Thompson, 1957) i.e. $R_{1b}1$ ammonoid zone, which delineates the latter stages (*ca* 320.0 Ma) of a protracted interglacial period that concluded at *ca* 319.5 Ma (Waters & Condon, 2012). The following outlines the potential for abandoned channels to form floodplain lakes which trap sediments during flood events and generate layered sedimentary fills through suspended load deposition, post-disconnection (Fig. 4.4B) (Toonen *et al.*, 2012). Abandoned channels, which include: i. meander bend neck/chute cutoffs (Oxbow lakes; High sinuosity channels); and ii. channel-belt avulsion-abandonment of bifurcation channels (Low sinuosity channels), are formed through disconnection from the main channel and local switching of the main channel to a neighbouring section of the floodplain (Toonen *et al.*, 2012). The transitional stage from initial abandonment to complete disconnection, for abandoned bifurcation channels and oxbow lakes, may take centuries or a decade, respectively (Toonen *et al.*, 2012). Consequently, bifurcation channel lakes possess more proximal coarse-grained fill and less distal fine grained suspension load deposits (laminated fill) (Toonen *et al.*, 2012); conversely, oxbow lakes possess less proximal coarse-grained fill and more by distal fine grained suspension load deposits (Toonen *et al.*, 2012). Further, Constantine *et al.* (2010) argue that aggradation rates at the entrance of abandoned channels is a function of the diversion angle between the main (active) and disconnected (abandoned) channel (Fig. 4.4B) (cf. Ishii & Hori, 2016). Channels with high, or low, diversion angles experience rapid, or slow, channel disconnection and low, or high, levels of coarse-grained sediment deposition, respectively (cf. Ishii & Hori, 2016). Toonen *et al.* (2012) equate oxbow lakes with high diversion angles and abandoned bifurcation channel lakes with low diversion angles. Similarly, Citterio & Piégay (2009) show that former baided channels form straight and narrow lakes with low sedimentation rates (e.g. ~0-10 $mm.yr^{-1}$), whereas anastomosed and meandering channels form increasingly wider and sinuous channel lakes with correspondingly higher sedimentation rates, respectively (e.g. ~4-10 $mm.yr^{-1}$ – anastomosed channel lakes; ~3-26 $mm.yr^{-1}$ – meandered channel lakes). Shale partings and beds associated with the Lower Brimham Grit (see Thompson, 1957; Reid, 1996) may be related to the above processes, particularly to references of thin shale partings, although they may not be able to account for the apparent areal extent of some shale deposits. Further, the shallow ramp-type shelf margin associated with the Askrigg Block and Craven Basin boundary, was likely sensitive to temporal variations in base sea-level (Reid, 1996), which may have been influenced by subsidence linked to syn-sedimentary tectonic activity along the North Craven Fault. Such sensitivity to eustatic variations may have facilitated deposition of relatively thick intermittent shale horizons, which may have inter-fingered with the Lower Brimham Grit to form intermittent shale deposits; chalybite nodules and thin sandstone lenses in a shale parting observed by Thompson (1957) may be evidence of such influence. Chalybite [or more generally siderite ($FeCo_3$), see Bishop *et al.*, 2001] mineralisation is related anoxic (reducing) environments (Wenk & Bulakh, 2004), such as those related to shales.

Fig. 4.5 Location 16 - High Mill (Shaw Mills)
Metrics Plot and Palaeocurrent Azimuths

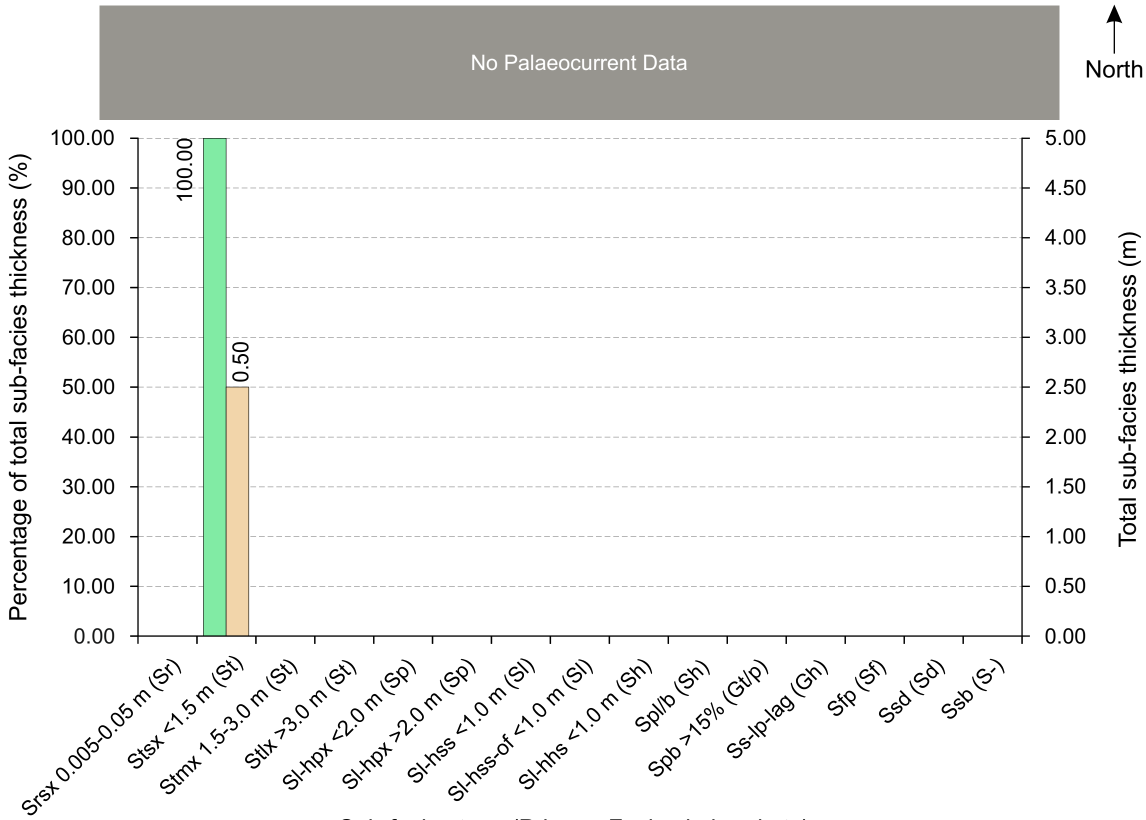


Fig. 4.6 Location 16 - High Mill (Shaw Mills)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

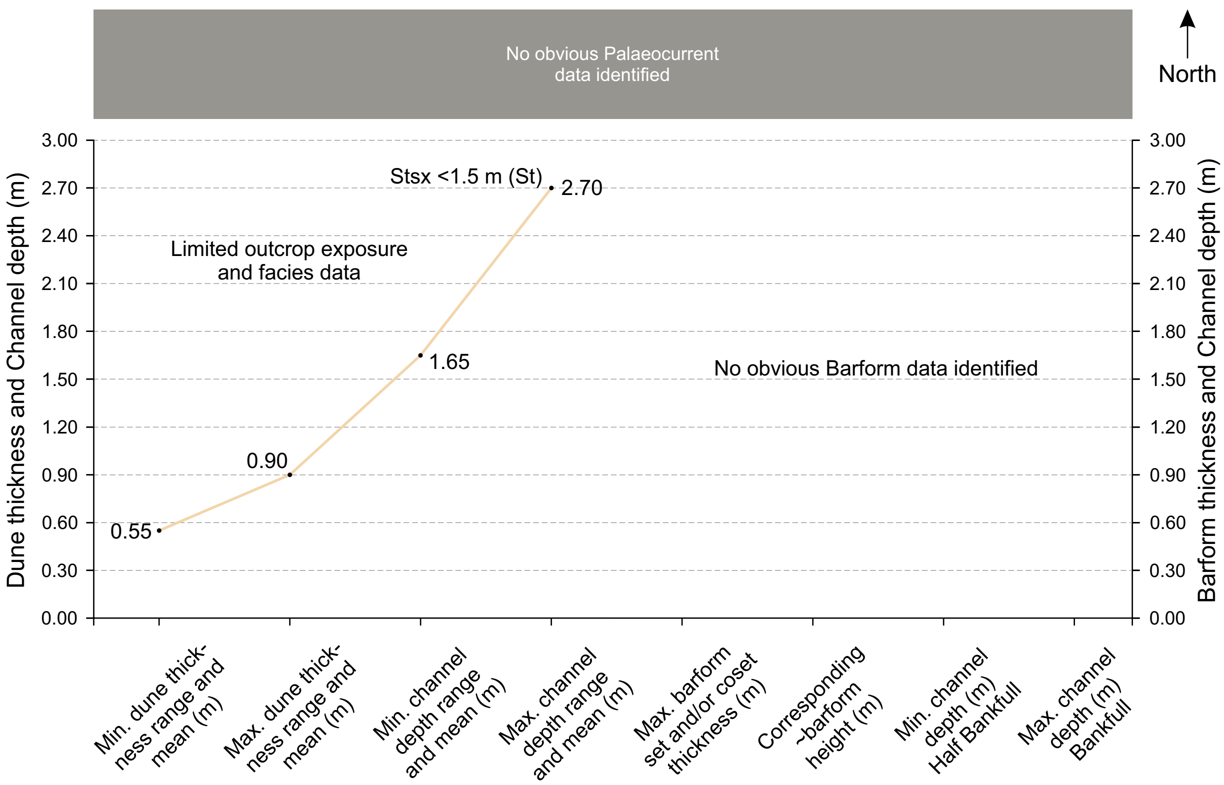


Fig. 4.4 Location 17 - Rabbit Hill Farm (Outcrops 17.1-17.3) - Grid ref's: SE 23492 65220 - SE 23482 65299 - Elevation: ~204 m - 210 m O.D. - A. Sedimentary log and palaeocurrents

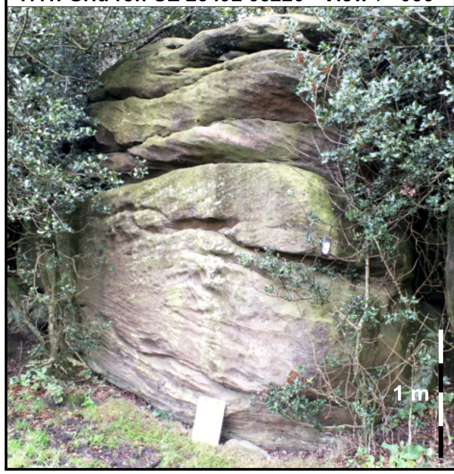
Interpretation: (Outcrops 17.1-17.3) Palaeocurrent data imply variable bedform migration and accretion influenced by westerly to easterly (Outcrop 17.1), southerly (Outcrop 17.2) and south-easterly to easterly (Outcrop 17.3) palaeocurrents (Fig. 4.4A). Variable set thicknesses of between 0.10 m (Sl-hss <1.0 m) and 0.60 m (Stmx 1.5-3.0 m) imply a maximum dune height and channel depth of ~2.15 m and 6.50 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger bar cosets (cf. Haszeldine, 1983b), therefore given that bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a coset thickness of ~1.30 m (facies Stsx <1.5 m) equates to a maximum bar height and channel depth of ~2.10 m and 4.20 m, respectively (Fig. 4.6) (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009; Leclair, 2011). Outcrop 17.1: Facies Sl-hss <1.0 m and Stsx <1.5 m may represent: i. downstream-accretion of 3D mesoforms within a relatively shallow thalweg region of a low sinuosity channel in fluenced by high-flow stage which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink *et al.*, 2014); ii. recurring downstream migration of 3D mesoforms, probably as a train of dunes over the crest or front/tail of a migrating channel bar (macroform) (cf. Allen, 1982; Haszeldine, 1983b; Miall, 2010b; Ashworth *et al.*, 2011); and/or, iii. individual sub-horizontal set components of a larger host dune coset (cf. Haszeldine, 1983b). Facies Sl-hss-of <1.0 m implies an increase in net sediment input and channel depth, likely resulting from a flood event (high-flow stage) with net lateral-accretion of 2D mesoforms during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011).

17.3. Grid ref: SE 23482 65299 - View ► 164˚

Such flood events may have also influenced thalweg migration and alterations in flow direction (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011); topographic lows along bar margins may limit falling-stage currents (Collinson, 1970; cf. Reesink *et al.*, 2014) and thereby promote lateral-accretion along bar margins (Collinson, 1970, 1996). Similarly, fluctuating palaeocurrent data imply that deposition may have been influenced by lateral-accretion and/or dune-scale bedform migration obliquely over, around and down a curved barform front/tail (cf. Haszeldine, 1983b).

17.2. Grid ref: SE 23494 65254 - View ► 040˚

17.1. Grid ref: SE 23492 65220 - View ► 036˚



Faccies Ssd suggests loss of grain stability (liquefaction) within unconsolidated water laden sediments likely facilitated by sudden overburden and/or syn-sedimentary tectonic activity (cf. Collinson *et al.*, 2006) along the North Craven Fault. Outcrop 17.2: See above interpretation relating to facies Sl-hss <1.0 m. Outcrop 17.3: Facies Spb >15% likely represent bedload transport which probably formed a mid-channel bar and nucleus for subsequent sediment deposition (cf. Allen, 1983) and compound bar formation. Such facies were likely generated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). See above interpretations relating to facies Sl-hss <1.0 m. Similarly, facies Sl-hpx <2.0 m and Stmx 1.5-3.0 m likely relate to downstream migration influenced by increasing channel depth facilitated by flood events (high-flow stage) and subsequent net sediment deposition (aggradation) during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). Such dunes tend to develop towards thalweg regions of relatively broad and deep channels (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Further, first and second-order sub-horizontal set and coset contacts, respectively, likely represent third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014) which may denote a component of lateral bedform migration and lag deposits likely represent scouring (Miall, 2010b) or winnowing (cf. Collinson *et al.,* 2006) processes. The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and subject to the inclination of their host bed most sets will climb at a similar angle (Leeder, 1982).

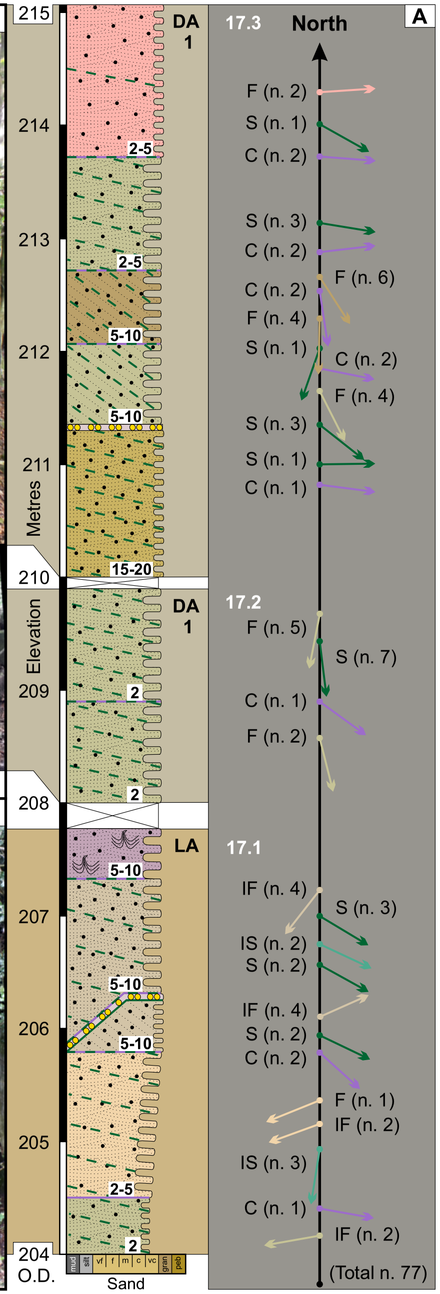


Fig. 4.5 Location 17 - Rabbit Hill Farm
Metrics Plot and Palaeocurrent Azimuths

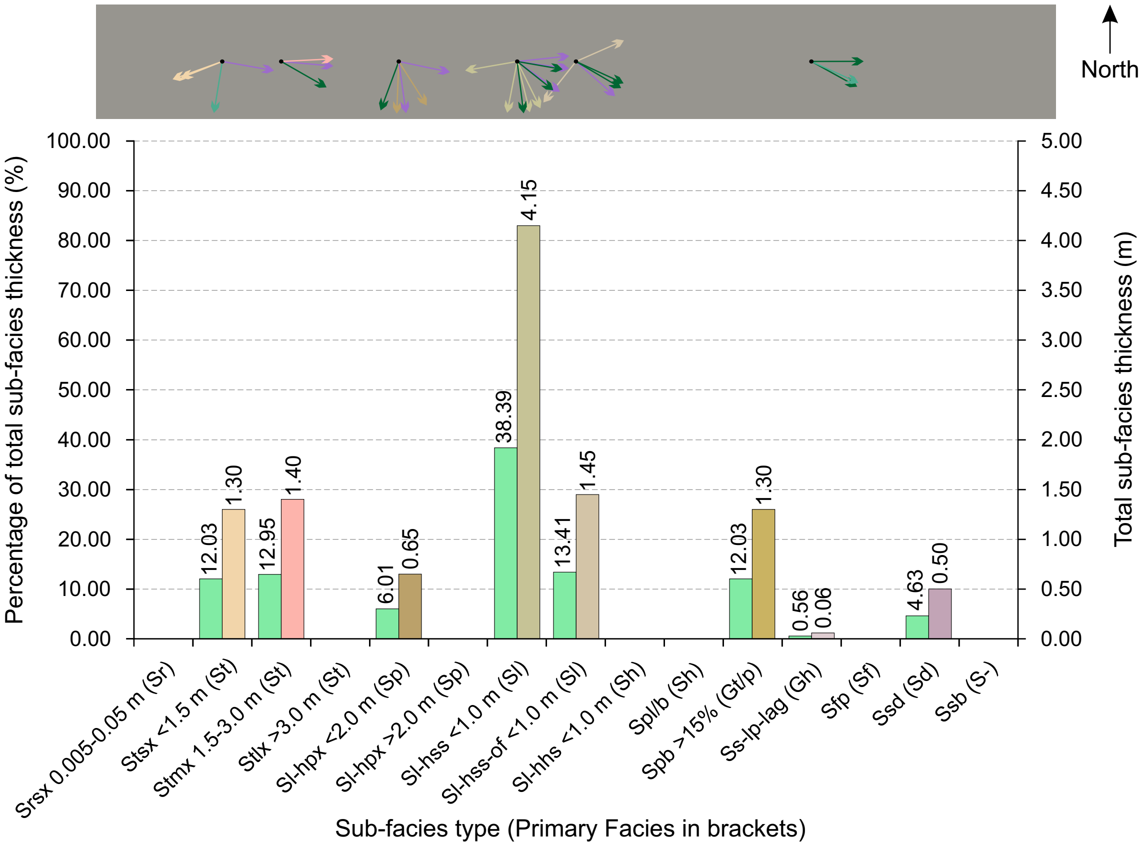


Fig. 4.6 Location 17 - Rabbit Hill Farm
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

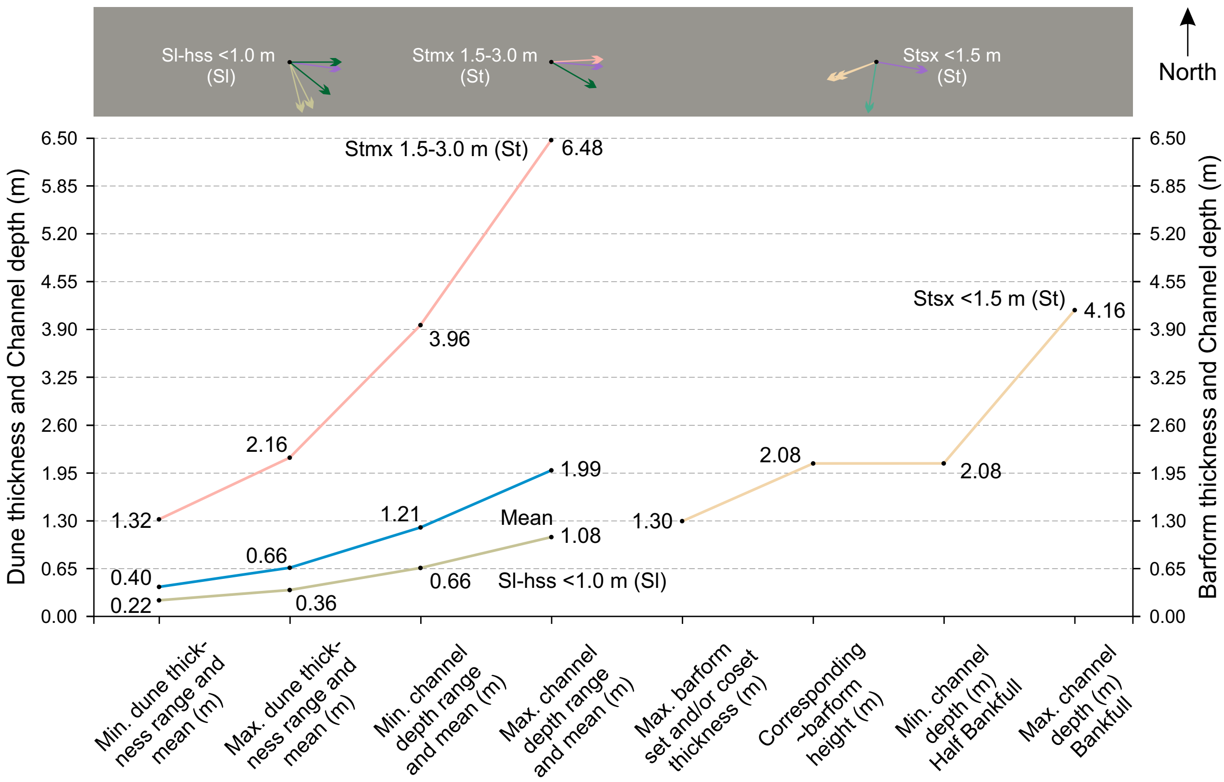
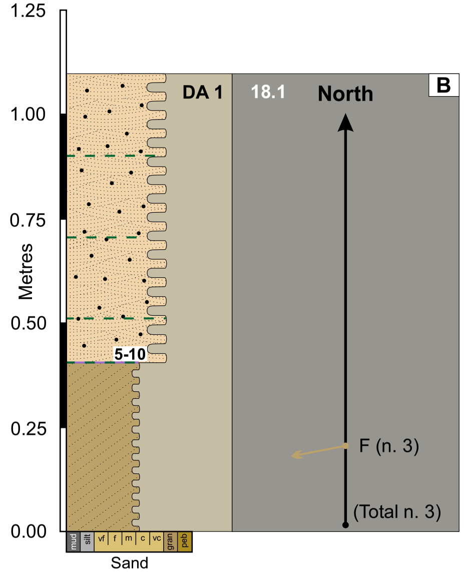
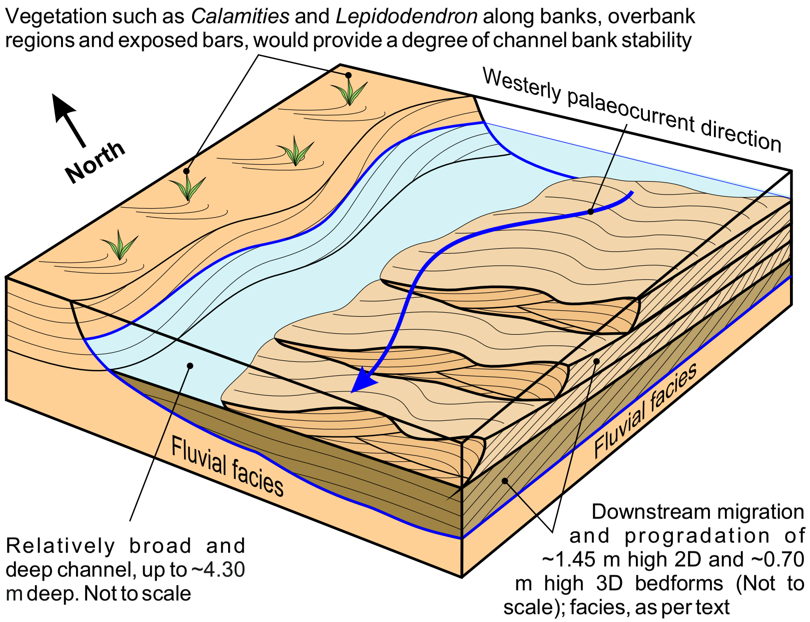


Fig. 4.4 Location 18 - Careless House Farm (Outcrop 18.1) - Grid ref: SE 25335 65113 - Elevation: ~140 m O.D. - Main view ► 310˚

A. Sedimentary log and palaeocurrents



B. Schematic representation of downstream-accreting bedforms



Interpretation: (Outcrop 18.1) Although limited, both in available outcrop and palaeocurrent data, the data obtained indicate that the principal depositional palaeocurrent was towards the west (Fig. 4.4A). The measured visible preserved set thickness of facies Sl-hpx <2.0 m (~0.40 m) suggests that the original height of the 2D mesoform and corresponding channel depth was at least ~1.45 m and ~4.30 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). The bedform likely relates to in channel downstream and/or lateral-accretion where sediment migration was facilitated by a flood event (high-flow stage) and subsequent net sediment deposition and aggradation of a 2D mesoform during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). Sediment aggradation inevitably encompasses a measure of channel fill and a reduction in the overall channel depth (cf. Cant & Walker, 1976; Leeder, 1982; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such conditions may account for the relatively reduced height of the ensuing facies of Stsx <1.5 m and a change from laminar to turbulent flow conditions, which would account for the undulating contact between the two units. The preserved set thickness of facies Stsx <1.5 m (~0.20 m) suggests that the original height of the 3D mesoform and corresponding channel depth was ~0.70 m and ~2.15 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). The relatively coarser sediment component of facies Stsx <1.5 m denotes an increase in flow velocity and downstream progradation and migration of 3D mesoforms, possibly on the surface of a larger sand flat (cf. Cant & Walker, 1976, 1978) and facilitated by facies Sl-hpx <2.0 m (Fig. 4.4B). Equally, bedforms consisting of facies Stsx <1.5 m may also relate to a series of distinct depositional episodes (cf. Collinson *et al.,* 2006) of assembled sets divided by first-order set boundaries which indicate repeated bedform migration, probably as a train of dunes (dune stacking) which may have formed components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011); preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and subject to the inclination of their host bed most sets will climb at a similar angle (Leeder, 1982).

Fig. 4.5 Location 18 - Careless House Farm
Metrics Plot and Palaeocurrent Azimuths

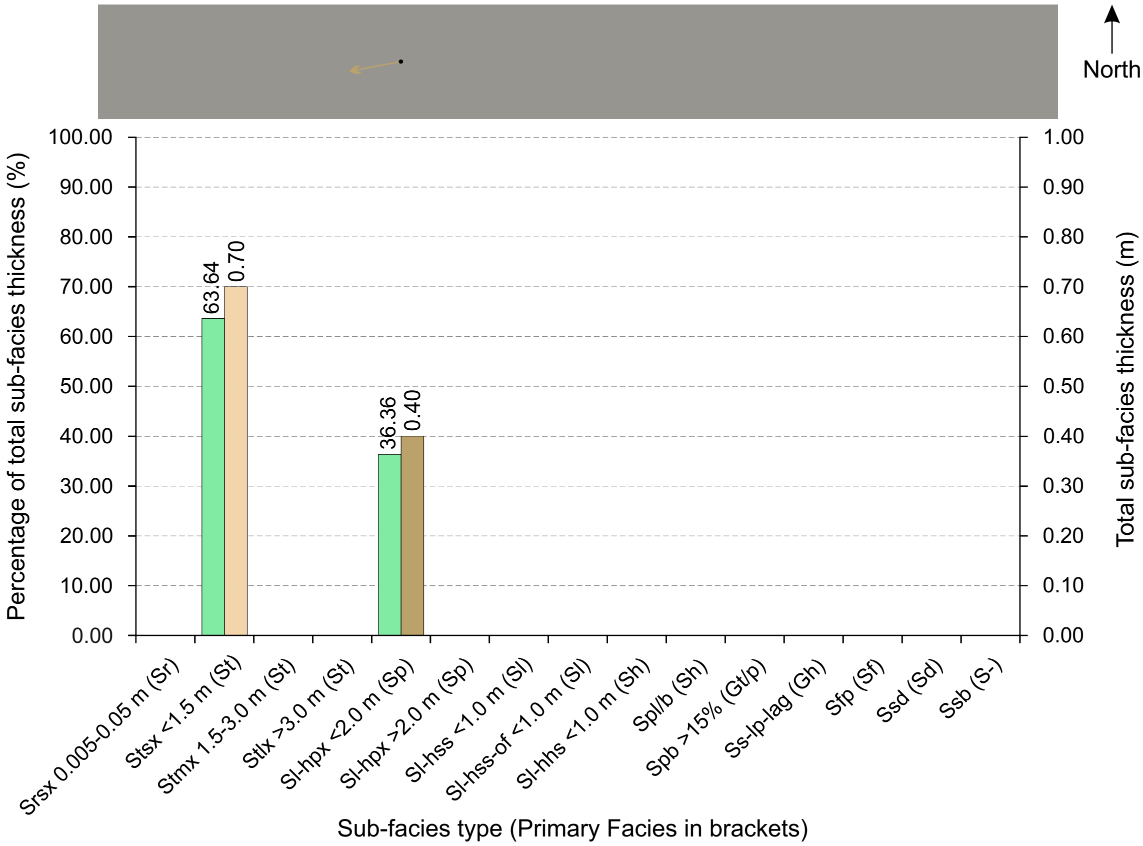


Fig. 4.6 Location 18 - Careless House Farm
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

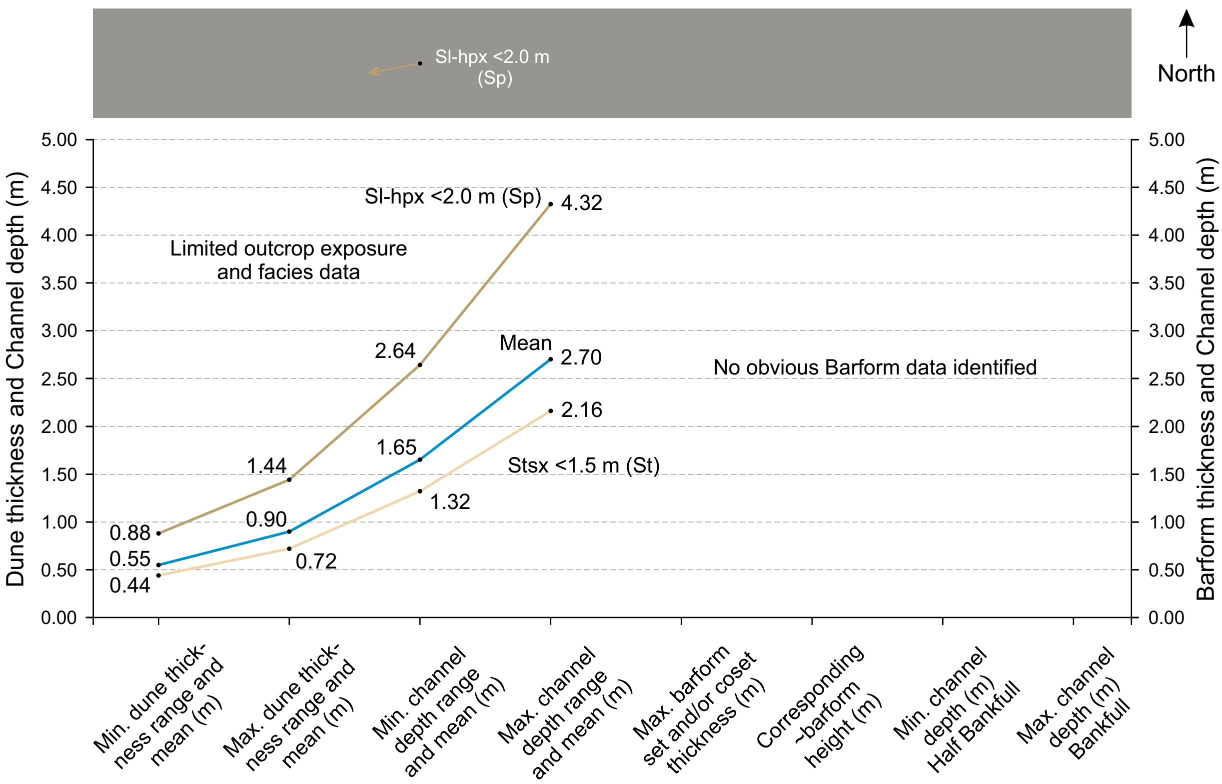
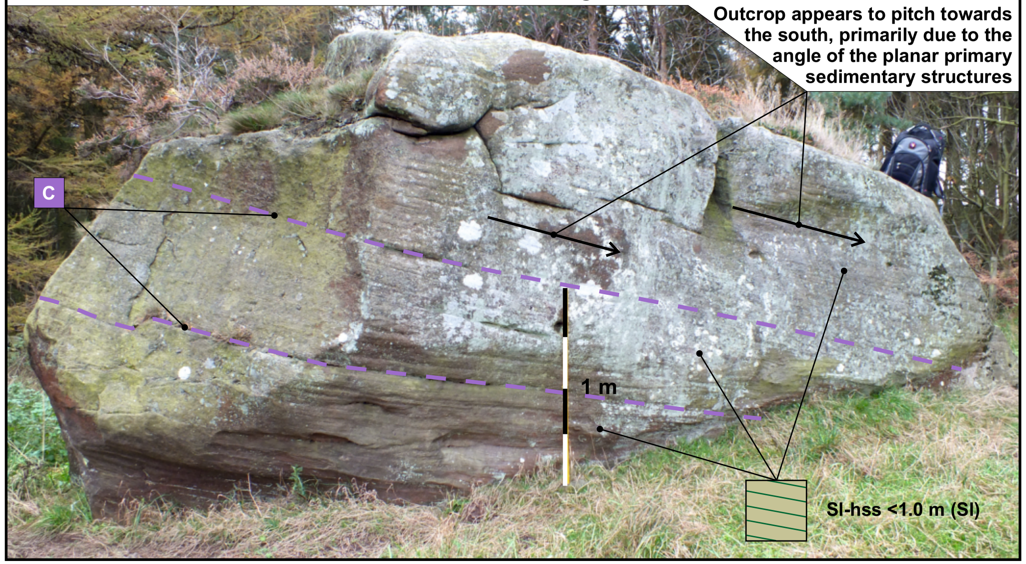
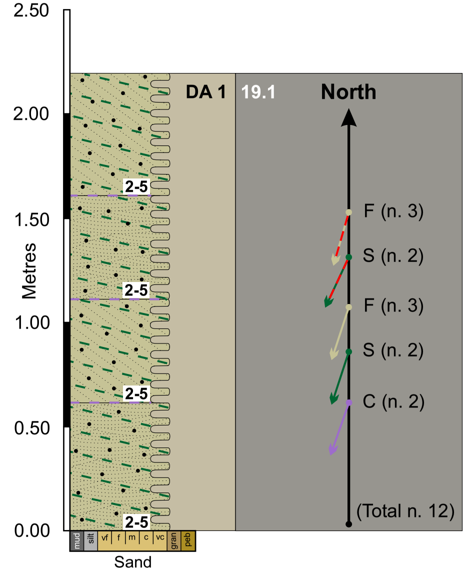


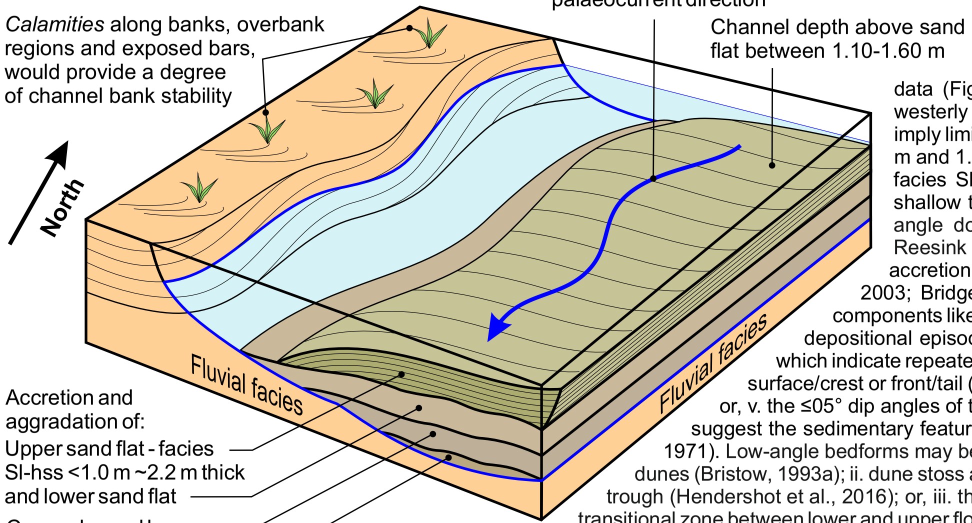
Fig. 4.4 Location 19 - Klondike (Disused Quarry - Outcrop 19.1) - Grid ref: SE 22346 65801 - Elevation: ~260 m O.D. - Image view ► 130˚



A. Sedimentary log and palaeocurrents



B. Schematic representation of Sand Flat sequence



(Sequence modified from Cant & Walker, 1978; Not to scale)

Interpretation: (Outcrop 19.1) Outcrop appears influenced by minor cambering, due to an apparent pitch towards the south. Bedding and palaeocurrent data were restored through stereographic projection relative to the 15˚ dip and 200˚ azimuth implied from coset inclination of facies Sl-hss <1.0 m. Restored palaeocurrent data imply deposition was influenced by palaeocurrents more variable than original field data (Fig. 4.4A), although restored azimuth means appear consistent with the south-south-westerly palaeocurrents of original data (Fig. 4.4A). The predominant set thickness of 0.10-0.15 m imply limited sediment input and a maximum dune height and channel depth of between 0.35-0.55 m and 1.10-1.60 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6). Cosets of facies Sl-hss <1.0 m may represent: i. downstream-accretion of 2D/3D mesoforms within a shallow thalweg of a low sinuosity channel influenced by high-flow stage which facilitated low-angle down-climbing dune formation and downstream migration (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Miall, 2010b; Ghinassi, 2011; Reesink *et al.,* 2014); ii. bar top vertical-accretion, due to dune stacking and relative shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006); iii. migratory mid-channel bar bedform components, with dune set components likely forming within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014); iv. a series of depositional episodes(cf. Collinson *et al.,* 2006) of assembled sets divided by first-order set boundaries which indicate repeated downstream bedform migration, possibly a train of dunes over a larger bar (macroform) surface/crest or front/tail (cf. Allen, 1982; Haszeldine, 1983b; Bristow, 1993b; Miall, 2010b; Ashworth *et al.*, 2011); or, v. the ≤05° dip angles of the restored data, normal set and foreset grading and linear form of bedding sequence, suggest the sedimentary features may resemble thin sand waves generated at very shallow fluvial depths (cf. Smith, 1971). Low-angle bedforms may be attributed to: i. shallow flow conditions subduing dune formation to generate low relief dunes (Bristow, 1993a); ii. dune stoss and crest erosion during high flow-stage and deposition of eroded sediment in the dune's trough (Hendershot et al., 2016); or, iii. the migration of low-amplitude (near horizontal) sand waves/dunes concomitant with the transitional zone between lower and upper flow regimes of very shallow fluvial systems (cf. Smith, 1971; Todd, 1996); generally foreset gradients decline as a flow regime intensifies, vice versa (cf. Smith, 1972). Shallow channel conditions also suggest waning flow and net aggradation during the latter stages of a channel fill sequence (cf. Cant & Walker, 1976, 1978; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb relative to the angle/dip of their host bed (Leeder, 1982). Hence, Outcrop 19.1 likely represents downstream migration and accretion of small-scale dune components of a host sand flat and channel fill (Fig. 4.4B) .

Fig. 4.5 Location 19 - Klondike (Disused Quarry)
Metrics Plot and Palaeocurrent Azimuths

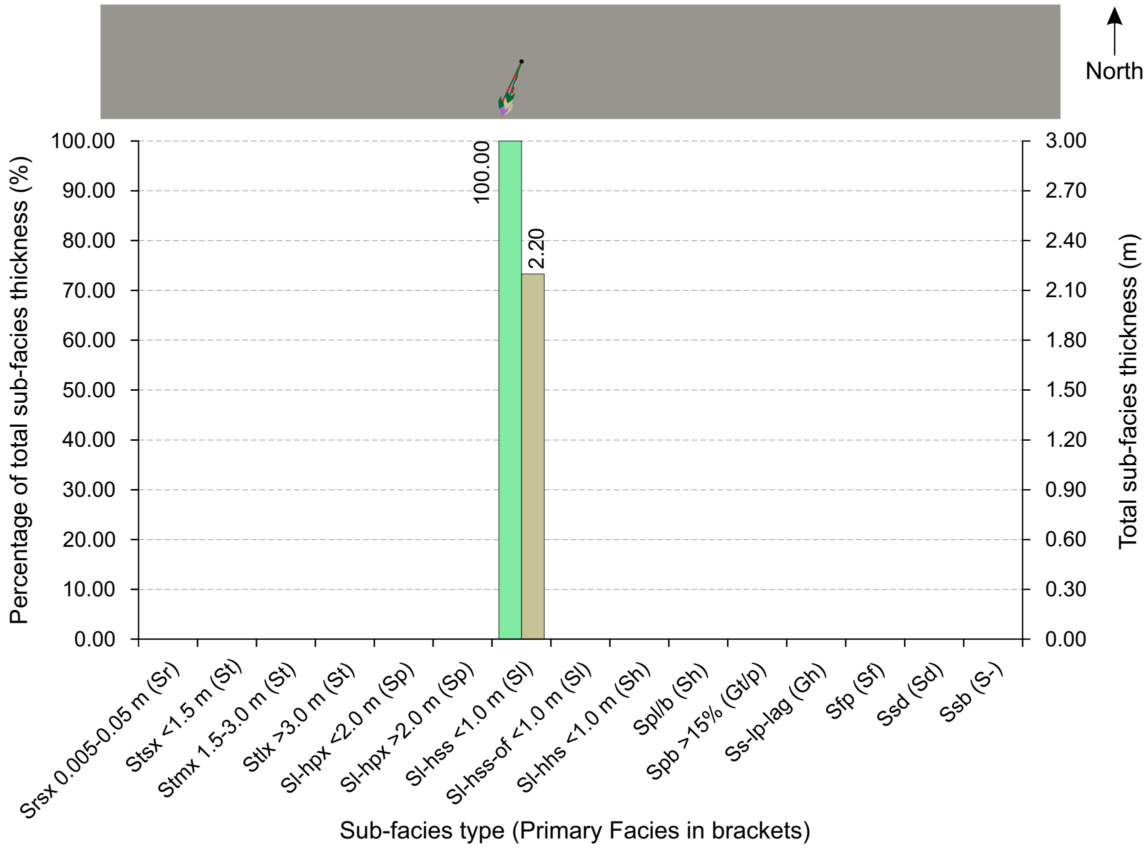


Fig. 4.6 Location 19 - Klondike (Disused Quarry)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

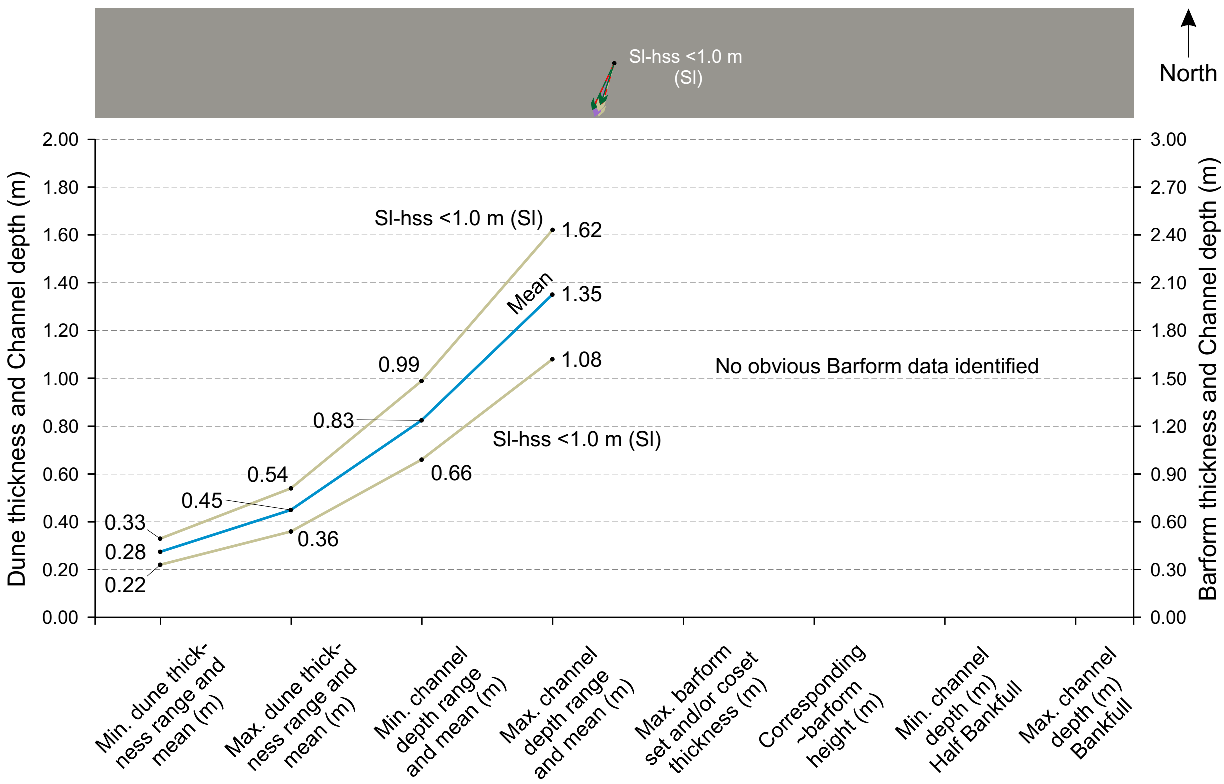
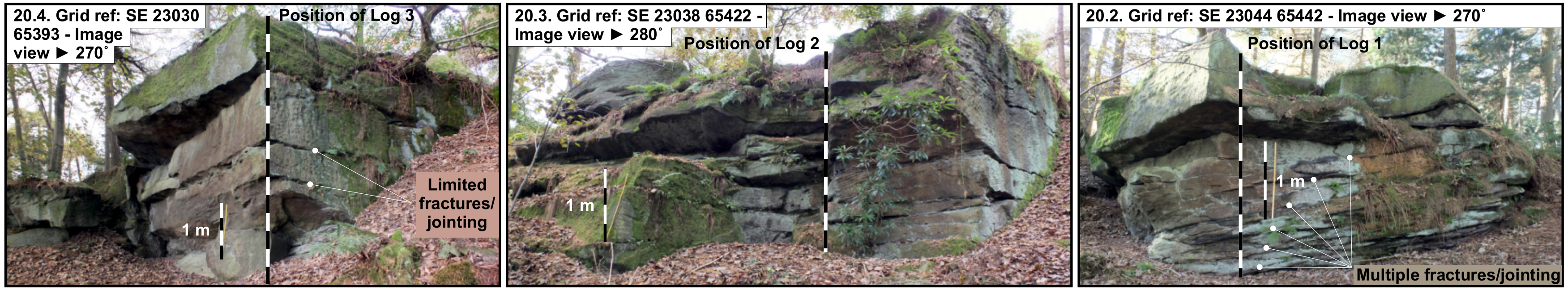
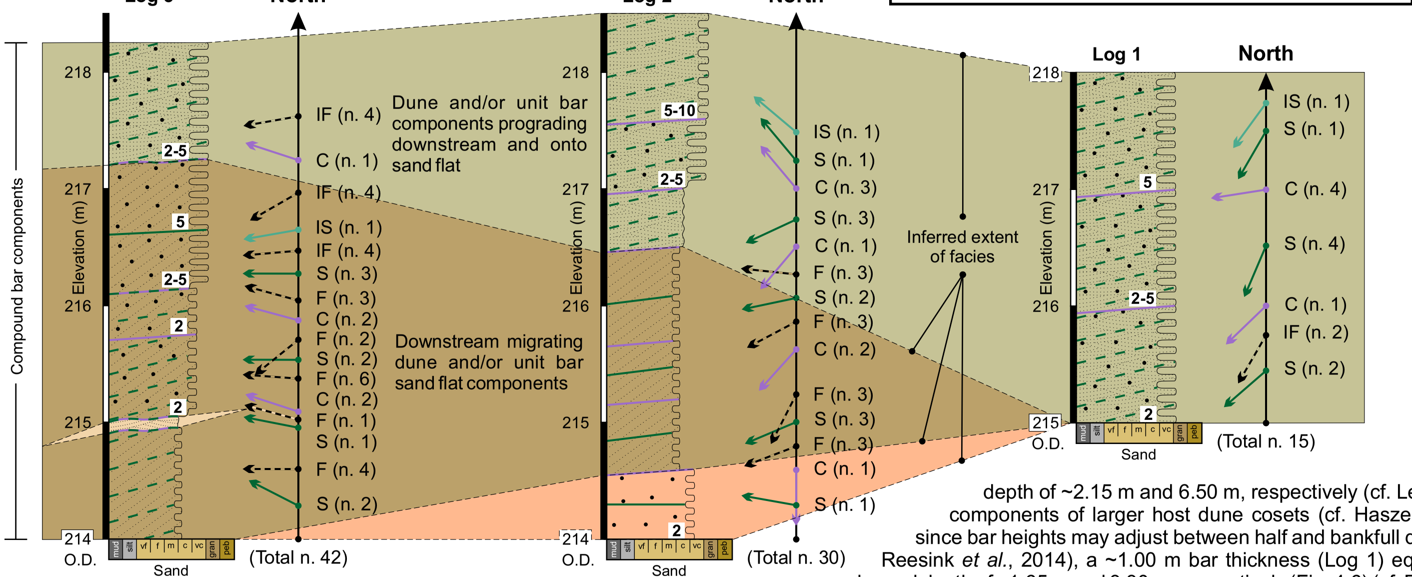


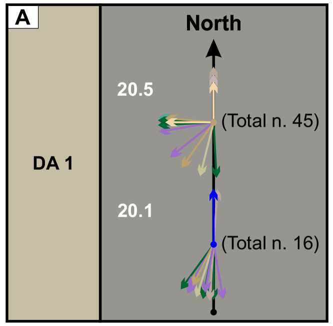
Fig. 4.4 Location 20 - Jeffery Crags (Outcrops 20.1-20.5) - Grid ref's: SE 23056 65454 - SE 22989 65399 - Elevation: ~215 m - 218 m O.D.



B. Fence diagram depicting possible sand flat unit bar and dune components



A. Palaeocurrent data for Outcrops 20.1 and 20.5 - Grid ref's: SE 23056 65454 and SE 22989 65399 (Not illustrated)



Interpretation: (Outcrops 20.2-20.4) Generally, field data implies that the palaeocurrent varies from a south-westerly (Outcrop 20.2) to westerly (Outcrop 20.4) direction (Fig. 4.4B). Variable set thicknesses of between 0.10 and 0.60 m (facies Stsx <1.5 m and Sl-hpx <2.0 m, respectively) imply a maximum dune height and channel depth of ~2.15 m and 6.50 m, respectively (cf. Leclair, 2011). Individual sets may form components of larger host dune cosets (cf. Haszeldine, 1983b) and/or bars, therefore, since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~1.00 m bar thickness (Log 1) equates to a maximum bar height and channel depth of ~1.65 m and 3.30 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011).

The principal facies relating to Outcrops 20.2- 20.4 are similar implying continued south-westerly downstream-accretion and >30 m extension of genetically related sandy bedforms . Facies Sl-hpx <2.0 m likely developed towards the channel thalweg where large dunes tend to develop; the size of cross-bedding and shallow inclined (≤14°) first-order bounding surface dips may correspond to a channel with high width to depth ratio (cf. Bristow, 1993a; Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such facies may relate to downstream migration of: i. longitudinal bars (Ghinassi *et al.*, 2009); and ii. unit bars (Ashworth *et al.*, 2011), which may form sand flat components (Fig. 4.4B) (cf. Cant & Walker, 1976, 1978). Facies Sl-hss <1.0 m may represent: i. downstream-accretion of 2D/3D mesoforms within a shallow thalweg region of a low sinuosity channel, where high-flow stage facilitated down-climbing dune formation (cf. Bristow, 1988, 1993a; Ghinassi et al., 2009; Miall, 2010b; Reesink *et al.*, 2014); ii. bar top vertical-accretion component of a channel bar, due to dune stacking and shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006); iii. mid-channel bar bedform components, dune set components of such cosets likely formed within a multi-channelled fluvial system (cf. Reesink et al., 2014), each coset may form individual consecutive small-scale unit bar components (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009) of a larger compound bar (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011); iv. individual sub-horizontal set components of a larger host dune coset (cf. Haszeldine, 1983b); or v. distinct depositional episodes (cf. Collinson *et al.*, 2006) of assembled sets divided by first-order set boundaries indicating repeated downstream bedform migration, possibly as a train of dune components over the surface/crest or front/tail of a larger bar (macroform) (cf. Allen, 1982; Haszeldine, 1983b; Bristow, 1993b; Miall, 2010b; Ashworth *et al.*, 2011). The coarse grain component of Log 1 and general coarsening-up sequence of Logs 2 and 3, imply downstream progradation and accretion of medium to small-scale sand flat dune/ bar components of a host compound bar and channel fill (cf. Cant & Walker, 1976, 1978) (Fig. 4.4B) .

Fig. 4.5 Location 20 - Jeffery Crags (Warren Forest Park)
Metrics Plot and Palaeocurrent Azimuths

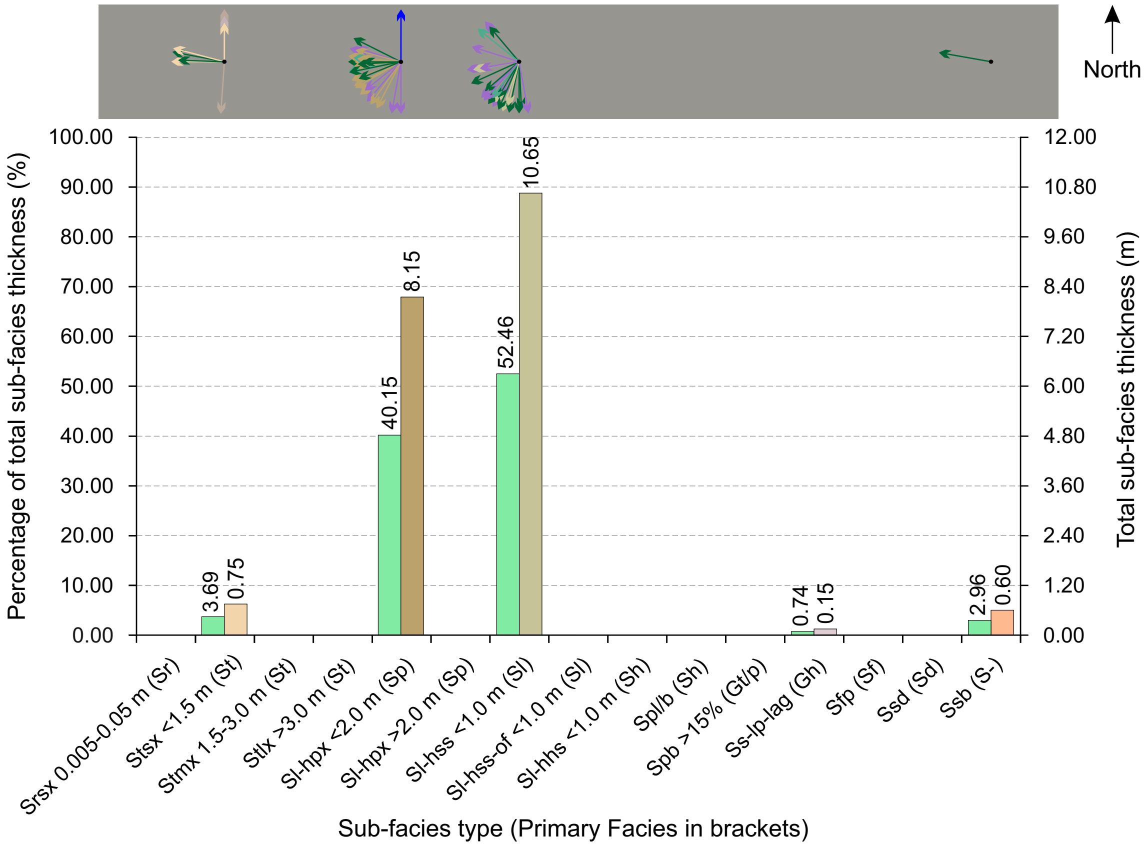


Fig. 4.6 Location 20 - Jeffery Crags (Warren Forest Park)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

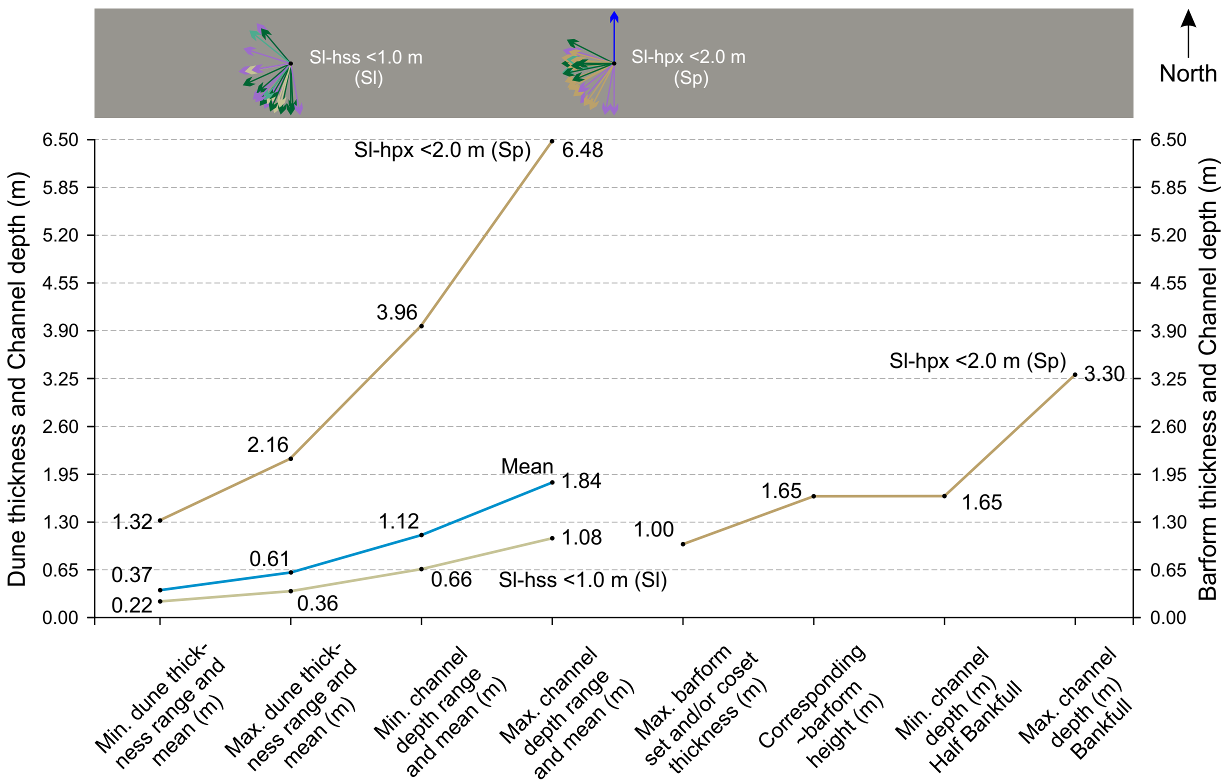
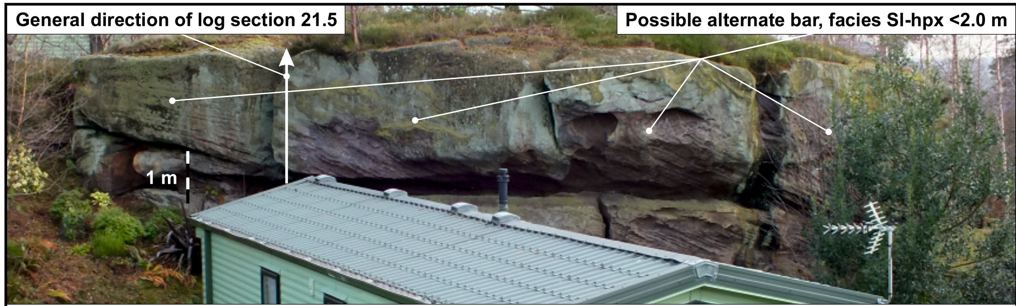
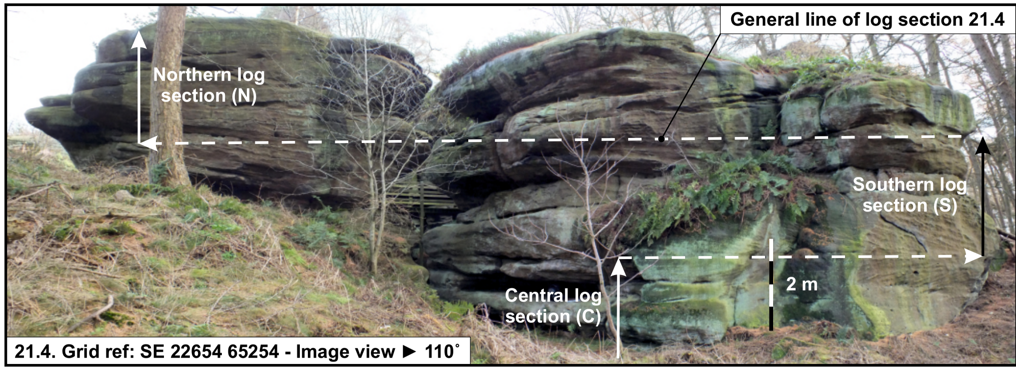


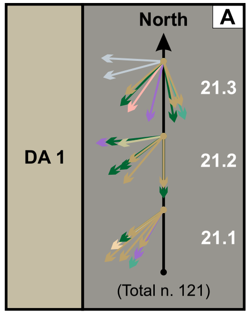
Fig. 4.4 Location 21 - Bilberry Wood (Outcrops 21.1-21.5) - Grid ref's: SE 22727 65245 - SE 22674 65314 - Elevation: ~215 m - 231 m O.D. - A. Sedimentary log and palaeocurrents

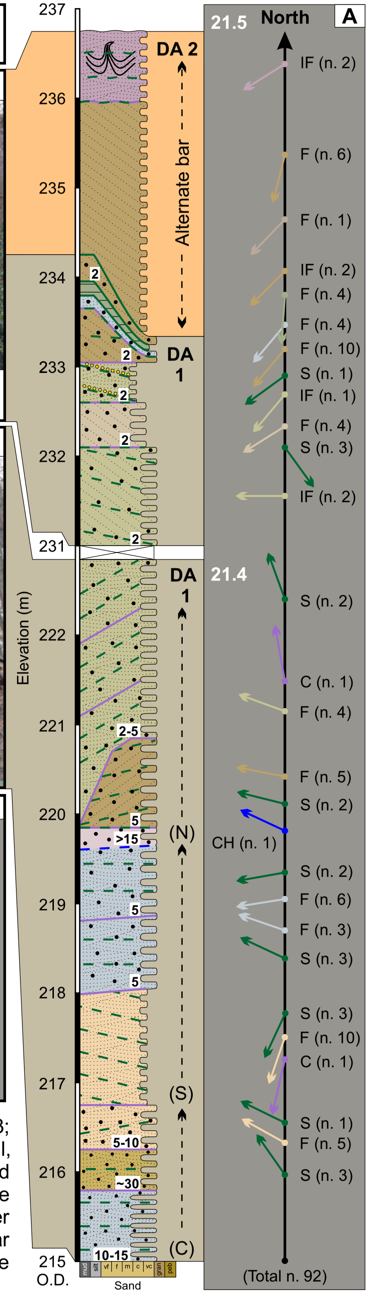


21.5. Grid ref: SE 22674 65314 - Image view ► 135˚. Facies details not included for Outcrops 21.1, 21.2 and 21.3 - Grid ref's: SE 22727 65245, SE 22717 65244 and SE 22680 65236



21.4. Grid ref: SE 22654 65254 - Image view ► 110˚





Interpretation: (Outcrops 21.1-21.5) Generally, facies and palaeocurrent data imply deposition was influenced by a mixture of mainly westerly and south-westerly migrating channel dunes and bars (Fig. 4.4A). The variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events (high-flow stage) and subsequent net sediment (dune/bar) deposition during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). The predominant set thickness of 0.10-0.15 m imply limited sediment input and a maximum dune height and channel depth of between 0.35-0.55 m and 1.10-1.60 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). Although, distinct sub-horizontal sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), a set thickness ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006). For example, since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a 1.70 m thick set (facies Sl-hpx <2.0 m, Oucrop 21.5) equates to a maximum bar height and channel depth of ~5.10 m and 10.20 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. Therefore, distinct and recurring sets of down-climbing dunes (<1.0 m thick), likely influenced by high-flow stage (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011), may also form small-scale unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009), although such bar heights coincide with dune heights (Ashworth *et al.*, 2011). Palaeocurrent variations may represent fluvial readjustment due to flood initiated avulsion or lateral tilting facilitated by fault (syn-sedimentary tectonic) activity and/or subsidence along the North Craven Fault (cf. Kane *et al.*, 2010; Fidolini *et al.*, 2013). Such activity may also promote soft sediment deformation (Ssd e.g. flame structures; Outcrop 21.5) facilitated by loss of grain stability (liquefaction) within unconsolidated water laden sediments, influenced by water saturation and event(s) that triggered de-watering processes, for example sudden overburden post flood and/or syn-sedimentary tectonic activity post deposition (cf. Collinson *et al.*, 2006). Further, palaeocurrent fluctuations may correlate to the influence of bedform deposition (e.g. alternate bars, Outcrop 21.5) which may develop in channel confluence scour pools (Fig. 4.4B; cf. McCabe, 1977; Collinson, 1996; Collinson *et al.*, 2006) and would account for the apparent limited areal extent of the observed bar (McCabe, 1977); confluences are also associated with anastomosing channels (McCabe, 1977). Potential scour locations include, downstream of mid-channel bars, upstream of large emergent bars and erosion against channel or island banks (Miall, 2010b and references there in). Scours may extend to a depth six times the mean channel depth and may also develop avalanche aspects that facilitate lateral, oblique, or vertical infilling through avalanche deposits below mean channel depth, thereby promoting sediment preservation (Ashmore & Parker, 1983; Miall, 2010b and references there in). The lag deposit (facies Ss-lp-lag) at the base of facies Sl-hpx <2.0 m (Outcrop 21.4) likely represents scouring (Miall, 2010b) or winnowing (cf. Collinson *et al.*, 2006) processes, which may relate to a channel surface. Lag deposits are known to denote: i. basal flood deposits and high-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011); and ii. channel thalwegs (Fidolini *et al.*, 2013; Ghinassi *et al.*, 2014) where large bedforms tend to develop (Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Sub-horizontal coset/unit bar contacts are likely third-order erosional surfaces (cf. Miall, 2010b; Ielpi *et al.*, 2014), which denote a component of lateral coset (mesoform) accretion and growth of the host compound bar (macroform) through lateral and downstream-accretion (cf. Bridge & Lunt, 2006); although, Skelly *et al.* (2003) and Ashworth *et al.* (2011) (and references there in) argue that the distinction between compound bar and adjacent channel fill core deposits, in sandy braided fluvial systems, is problematic.

Fig. 4.5 Location 21 - Bilberry Wood (Warren Forest Park)
Metrics Plot and Palaeocurrent Azimuths

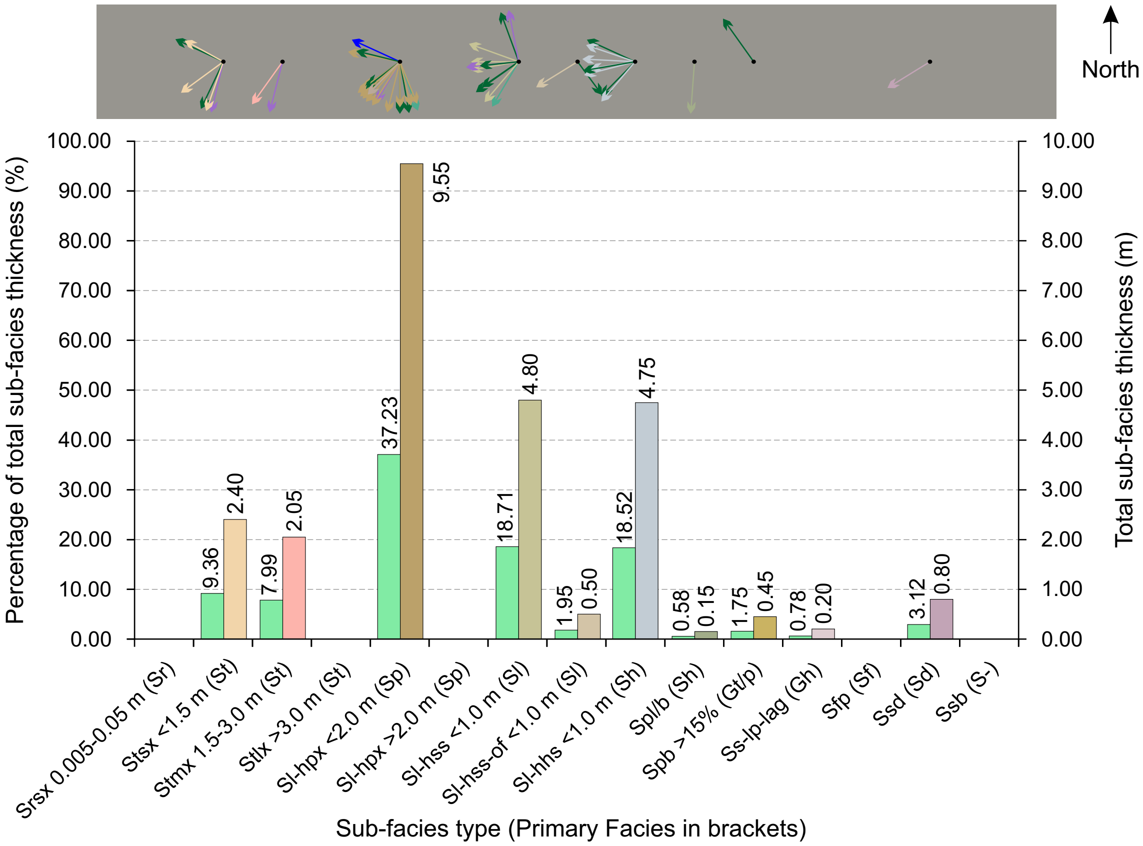


Fig. 4.6 Location 21 - Bilberry Wood (Warren Forest Park)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

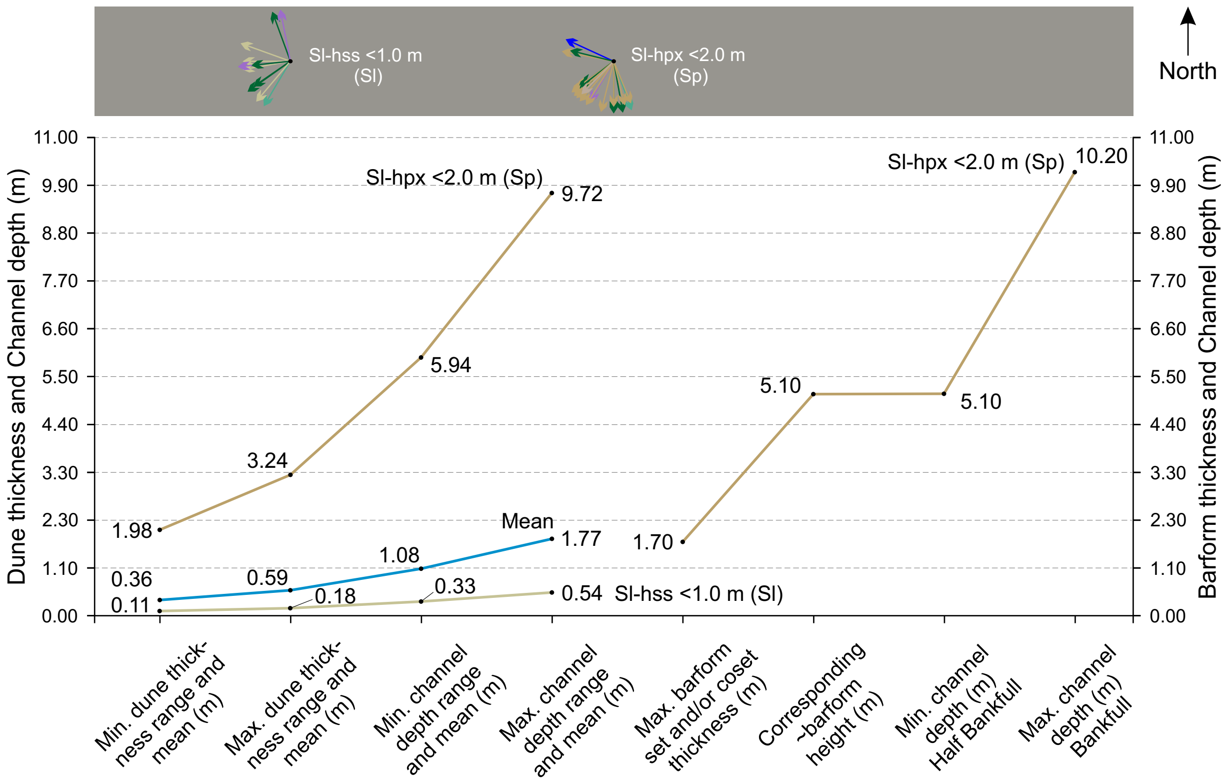
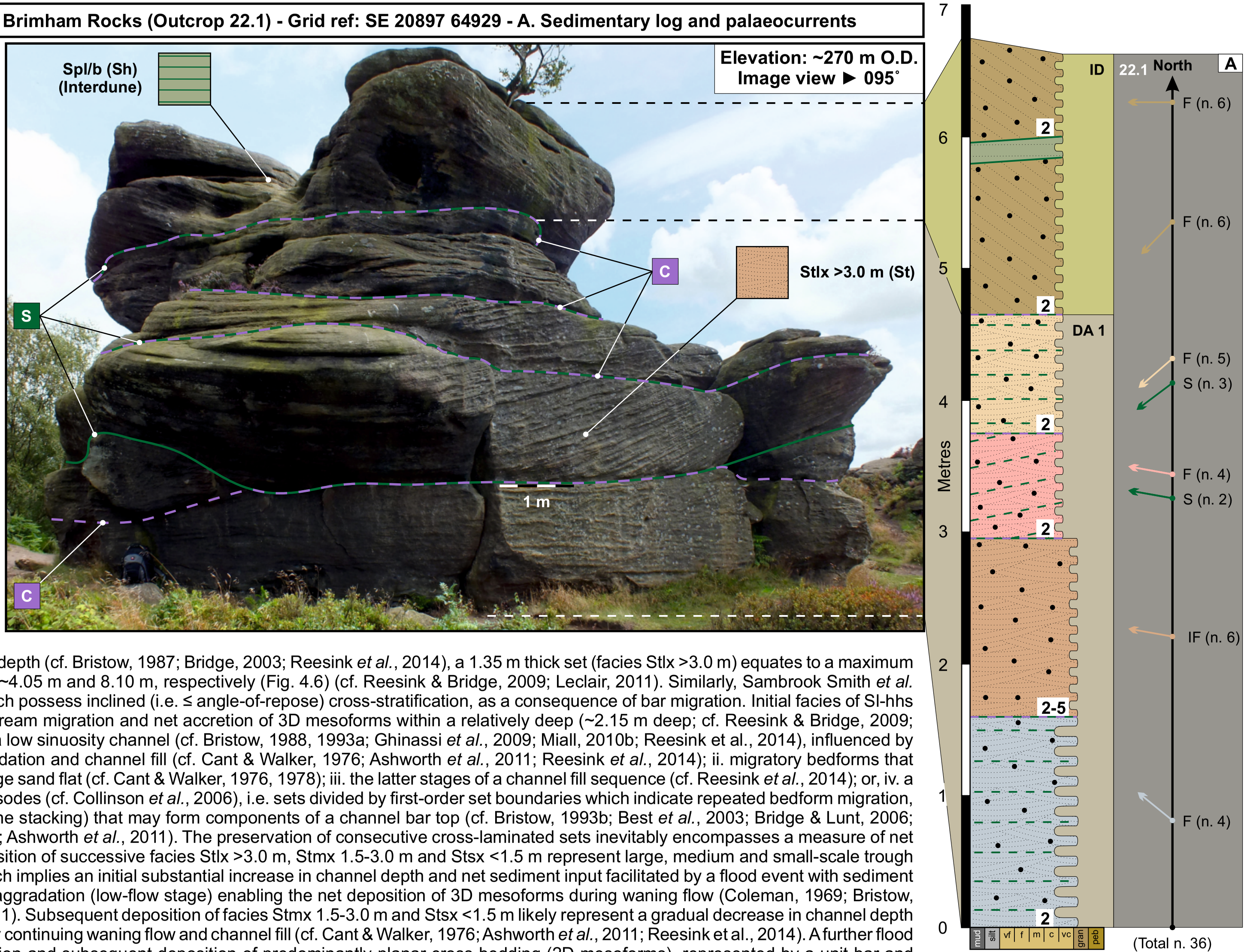


Fig. 4.4 Location 22 - Brimham Rocks (Outcrop 22.1) - Grid ref: SE 20897 64929 - A. Sedimentary log and palaeocurrents



Interpretation: (Outcrop 22.1) Facies and palaeocurrent data imply deposition was influenced by initial north-westerly and subsequent south-westerly migrating channel dunes and bars (Fig. 4.4A). The variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events and subsequent net sediment (dune/bar) deposition during waning flow (high and low-flow stages, respectively) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). A set thickness of ~0.15 m (facies Stsx <1.5 m) suggest limited sediment input and a maximum dune height/channel depth of ~ 0.55 m and 1.60 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). Although, distinct sub-horizontal sets may form components of larger host dune cosets (cf. Haszeldine, 1983b), a set thickness ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006). For example, since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a 1.35 m thick set (facies Stlx >3.0 m) equates to a maximum bar height and channel depth of ~4.05 m and 8.10 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. Initial facies of Sl-hhs <1.0 m may represent: i. downstream migration and net accretion of 3D mesoforms within a relatively deep (~2.15 m deep; cf. Reesink & Bridge, 2009; Leclair, 2011) thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink et al., 2014), influenced by waning flow, net sediment aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); ii. migratory bedforms that developed on the surface of a large sand flat (cf. Cant & Walker, 1976, 1978); iii. the latter stages of a channel fill sequence (cf. Reesink *et al.*, 2014); or, iv. a series of distinct depositional episodes (cf. Collinson *et al.*, 2006), i.e. sets divided by first-order set boundaries which indicate repeated bedform migration, probably as a train of dunes (dune stacking) that may form components of a channel bar top (cf. Bristow, 1993b; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007; Miall, 2010b; Ashworth *et al.*, 2011). The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition (Leeder, 1982). Deposition of successive facies Stlx >3.0 m, Stmx 1.5-3.0 m and Stsx <1.5 m represent large, medium and small-scale trough cross-bedding, respectively, which implies an initial substantial increase in channel depth and net sediment input facilitated by a flood event with sediment migration (high-flow stage) and aggradation (low-flow stage) enabling the net deposition of 3D mesoforms during waning flow (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Subsequent deposition of facies Stmx 1.5-3.0 m and Stsx <1.5 m likely represent a gradual decrease in channel depth and sediment input, influenced by continuing waning flow and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink et al., 2014). A further flood event likely facilitated the migration and subsequent deposition of predominantly planar cross-bedding (2D mesoforms), represented by a unit bar and ensuing dune (facies Sl-hpx <2.0 m, ~1.20 m and ~0.70 m thick sets, respectively (cf. Bridge & Lunt, 2006; Ashworth *et al.*, 2011, see above) and intervening interdune (facies Spl/b). Such interdunes are associated with waning flow conditions (Collinson, 1996) (low-flow stage) whereby falling water levels, locally within interdune regions, likely increased the palaeocurrent velocity and thereby generate upper-stage (or lower-stage) plane-bed flow conditions which facilitated the deposition of planar interdune laminations (cf. Collinson, 1996; Carling *et al.*, 2000). Overall the facies associated with Outcrop 22.1 likely represent downstream migration and channel fill sequence relating to the thalweg region of a relatively deep and wide channel, where relatively large bedforms had the potential to develop (Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014) and migrate downstream.

Fig. 4.5 Location 22 - Brimham Rocks (Facies Stlx >3.0 m)
Metrics Plot and Palaeocurrent Azimuths

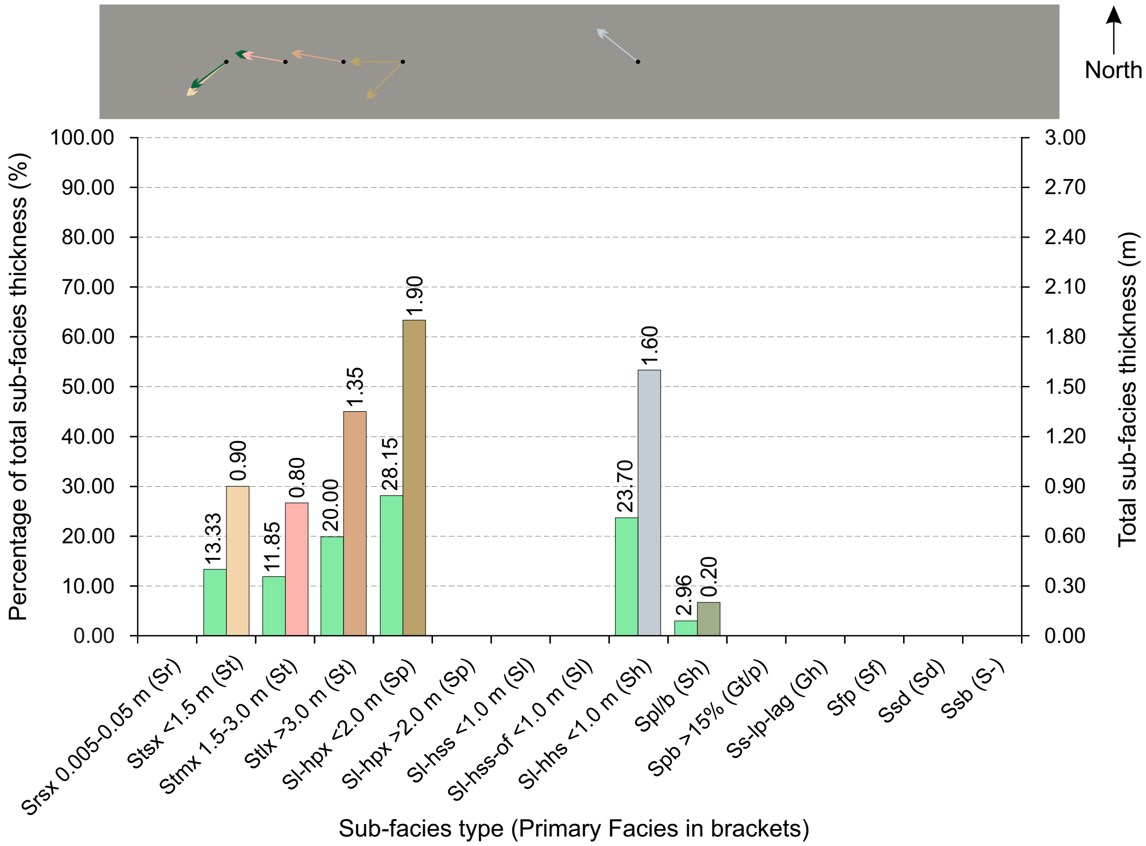


Fig. 4.6 Location 22 - Brimham Rocks (Facies Stlx >3.0 m)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

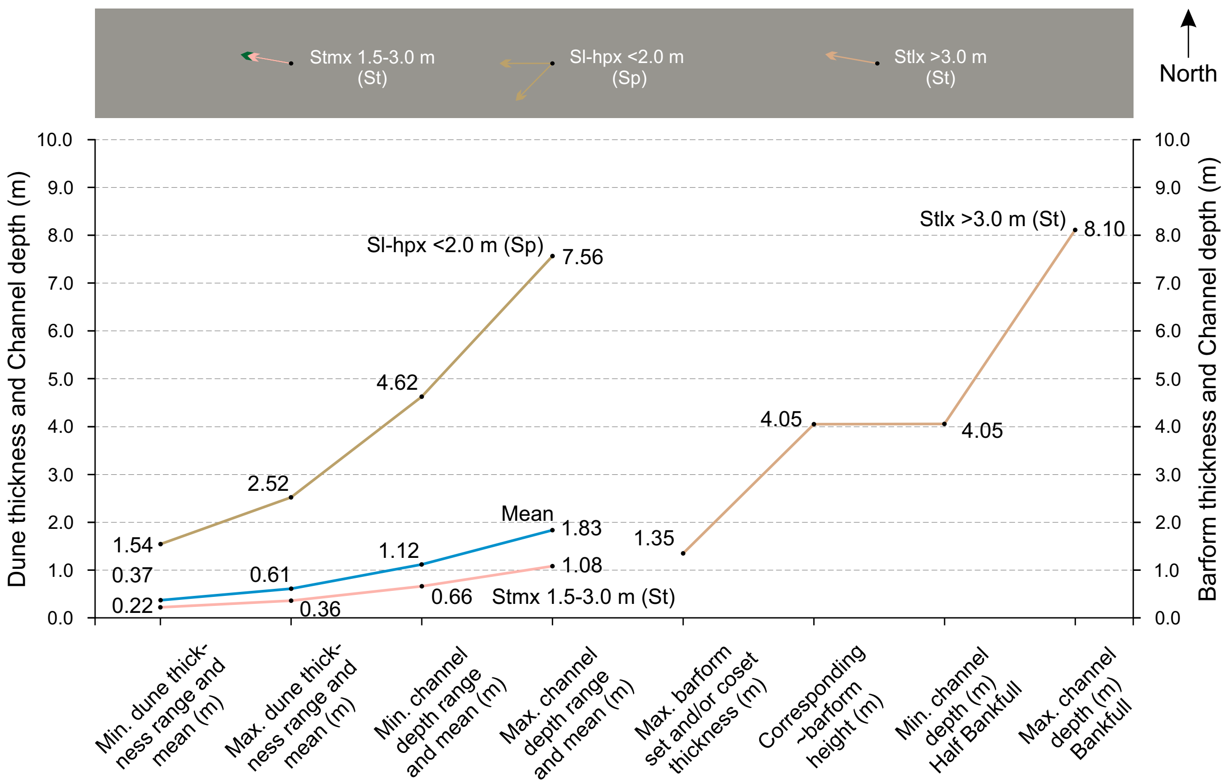
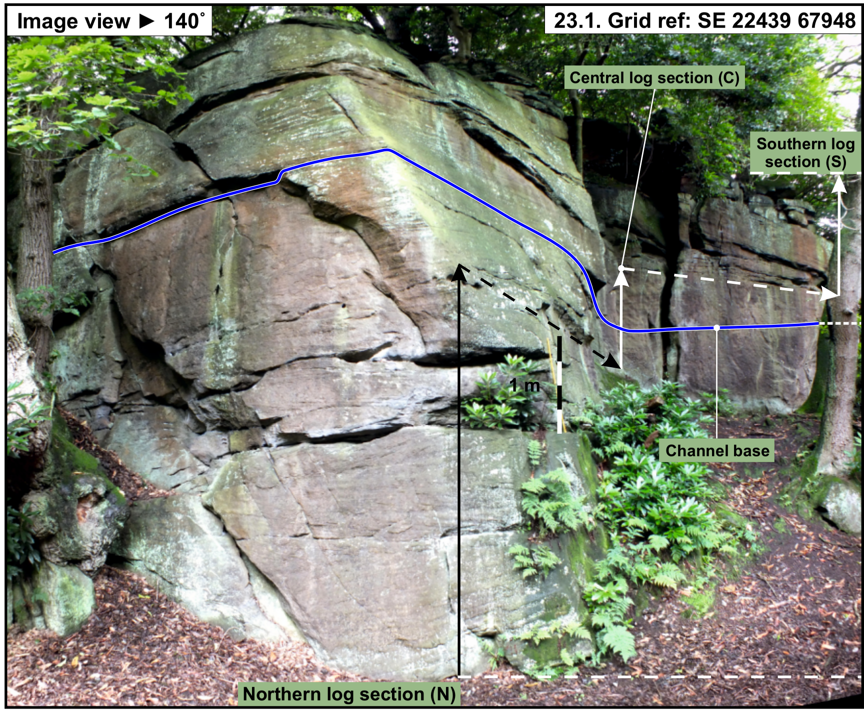
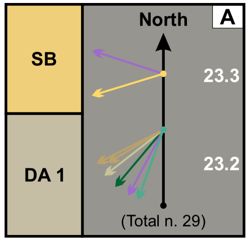
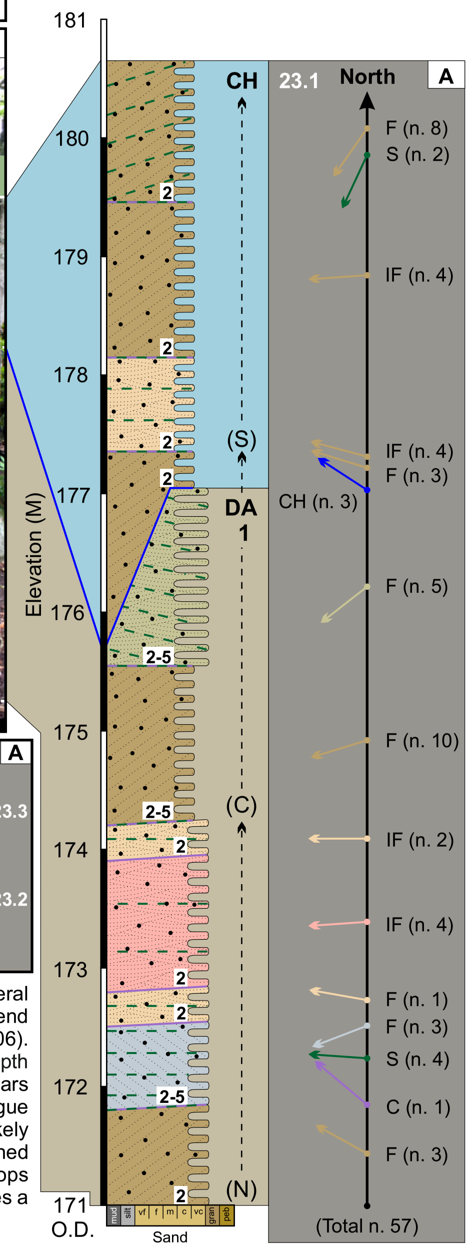


Fig. 4.4 Location 23 - Eavestone Lake (Outcrop 23.1) - Grid ref's: SE 22439 67948, SE 22700 67865 and SE 22842 67968 - Elevation: 171 m - 187 m O.D. - Facies details not included for Outcrops 23.2 and 23.3 - Grid ref's: SE 22700 67865 and SE 22842 67968





A. Sedimentary log and palaeocurrents



Interpretation: (Outcrops 23.1-23.3) Facies and palaeocurrent data imply deposition was influenced by westerly and south-westerly migrating channel dunes and bars (Fig. 4.4A). The variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events and subsequent net sediment (dune/bar) deposition during waning flow (high and low-flow stages, respectively) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). A set thickness of ~0.10 m (facies Sl-hhs <1.0 m) suggest limited sediment input and a maximum dune height/channel depth of ~0.35 m and 1.10 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). Although, distinct sub-horizontal sets (e.g. facies Sl-hss <1.0 m) may form components of larger host dune cosets (cf. Haszeldine, 1983b), a set thickness ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006). Since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a 1.60 m thick set (facies Sl-hpx <2.0 m) equates to a maximum bar height and channel depth of ~4.80 m and 9.60 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. Further, the shallow inclined (mainly ≤14°) second and fifth-order bounding surface dips (e.g. facies Sl-hhs <1.0 m and Sl-hpx <2.0 m, Outcrop 23.1) likely correspond to a channel possessing a high width to depth ratio (Bristow, 1993a). Outcrop 23.2 may represent a sand flat remnant constructed from component unit bars consisting of simple inclined (mainly <10°, but may be up to 35°) small to large-scale sets that may show a vertical reduction in dune/set height correlated to a decrease in channel depth, the deposits may also display no significant vertical shift in grain size (cf. Bridge & Lunt, 2006). These traits are consistent with the facies associated with Outcrop 23.2, which likely represent two sand flat unit bar components. The base and top of the initial unit bar is represented by facies Sl-hpx <2.0 m (~0.70 m thick set) and Sl-hss <1.0 m (~0.10 m thick sets), respectively, which is consistent with a gradual decrease in channel depth and available accommodation space for vertical dune accretion, there is also no obvious clear vertical grain size shift along the unit bar (cf. Bridge & Lunt, 2006). The upper unit bar consists of predominantly ~0.40 m thick sets of facies Sl-hpx <2.0 m. Comparable facies and palaeocurrents can be observed at an outcrop ~60.0 m due east (Grid reference: SE 22758 67866, not featured) of Outcrop 23.2, which suggests a possible lateral relationship between both outcrops and a minimum of ~60.0 m lateral extent of the sand flat. Cant & Walker (1978) note that sand flats may extend downstream and laterally for 50-2000 m and 30-450 m, respectively, and may cover up to 80% of a channel-belt's width (Sambrook Smith *et al.*, 2006). Similar to Outcrop 23.1, shallow inclined (≤12°) first and second-order bounding surface dips imply the host channel possessed a high width to depth ratio (Bristow, 1993a). Outcrop 23.3 probably represents a channel fill sequence, rather than a migratory mid-channel bar; although mid-channel bars inevitably contribute components related to channel fill processes and Skelly *et al.* (2003) and Ashworth *et al.*, 2011 (and references there in) argue that the distinction between compound bar and adjacent channel fill core deposits, in sandy braided fluvial systems, is problematic. The likely asymmetrical ripple morphology (facies Srsx 0.005-0.05 m) implies deposition was influenced by westerly palaeocurrents and the shallow inclined (10°) second-order bounding surface dip (facies Sl-hhs <1.0 m) suggests the host channel possessed a high width to depth ratio, similar to Outcrops 23.1 and 23.2 (Bristow, 1993a). Further, Leeder (1982) argues that the preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition, which implies that each foreset, set and coset represent contrasting scales of channel fill components.

Fig. 4.5 Location 23 - Eavestone Lake
Metrics Plot and Palaeocurrent Azimuths

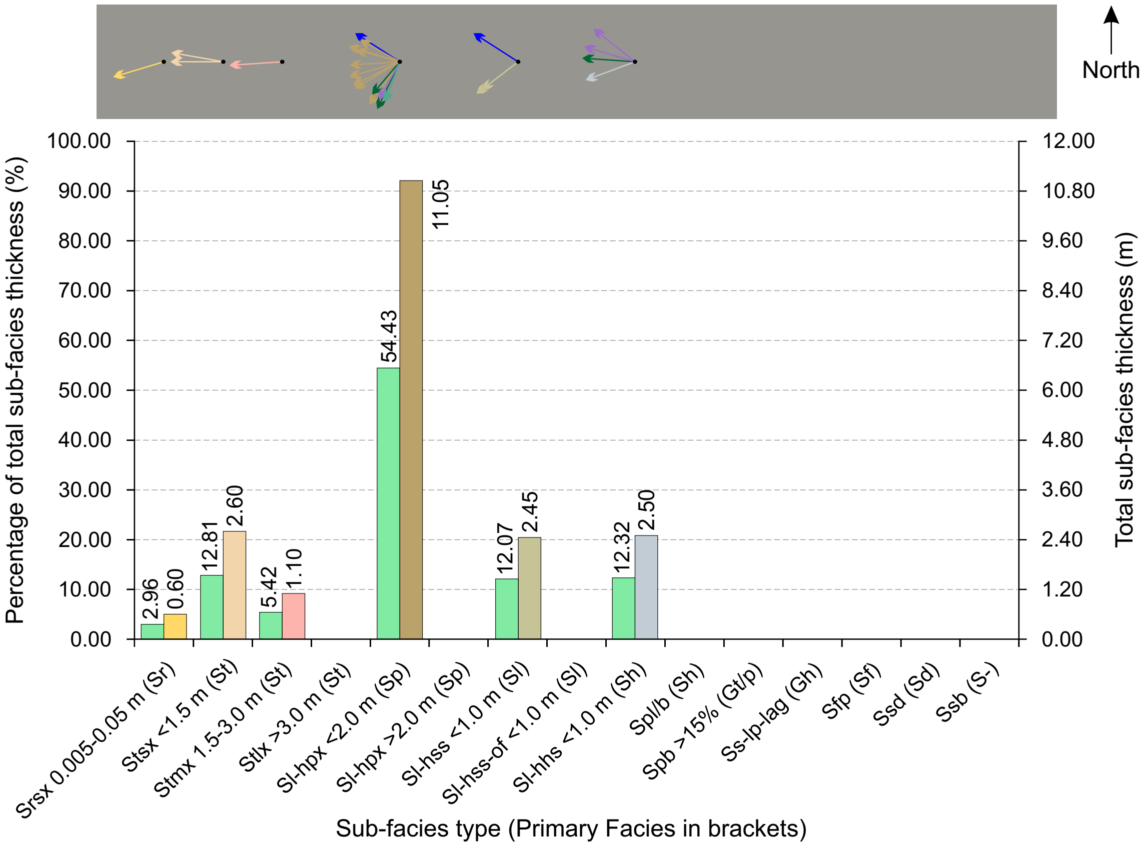


Fig. 4.6 Location 23 - Eavestone Lake
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

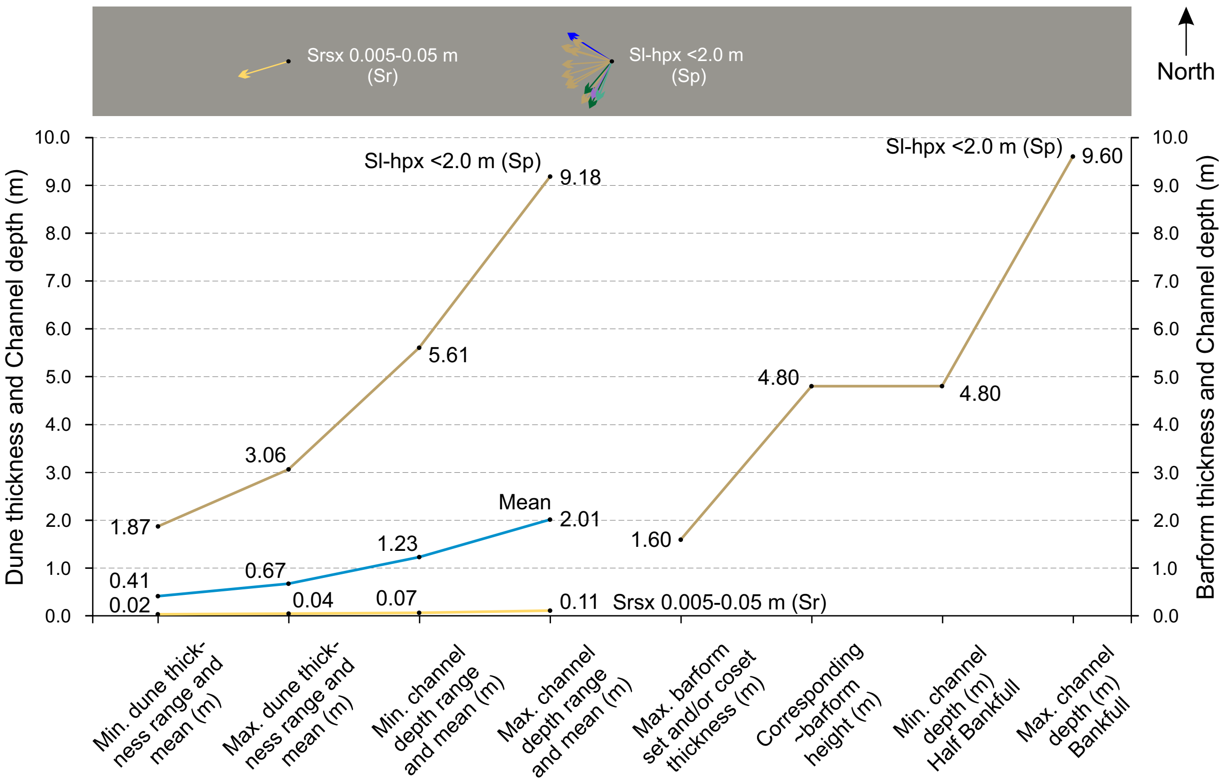
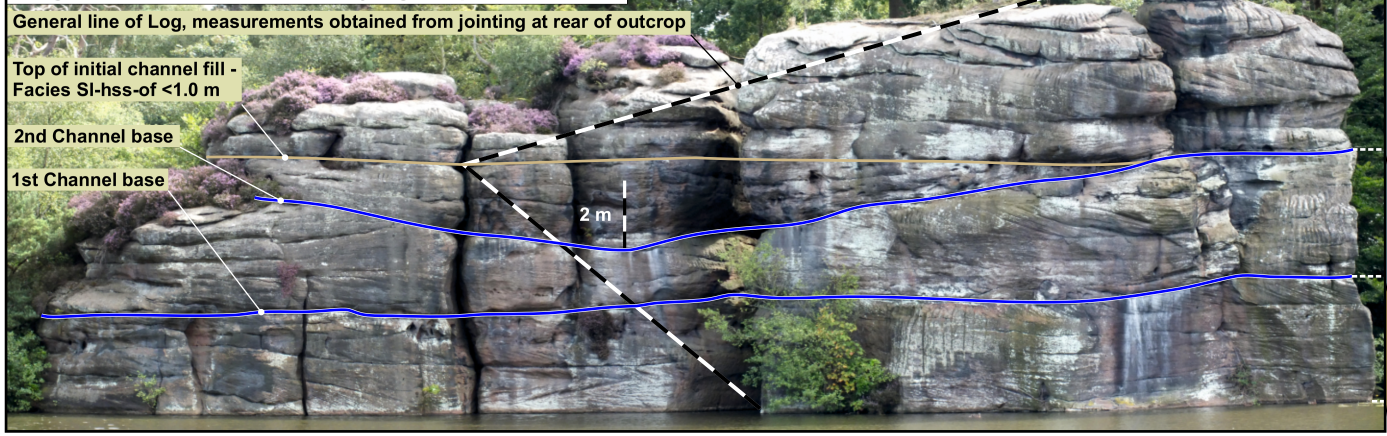
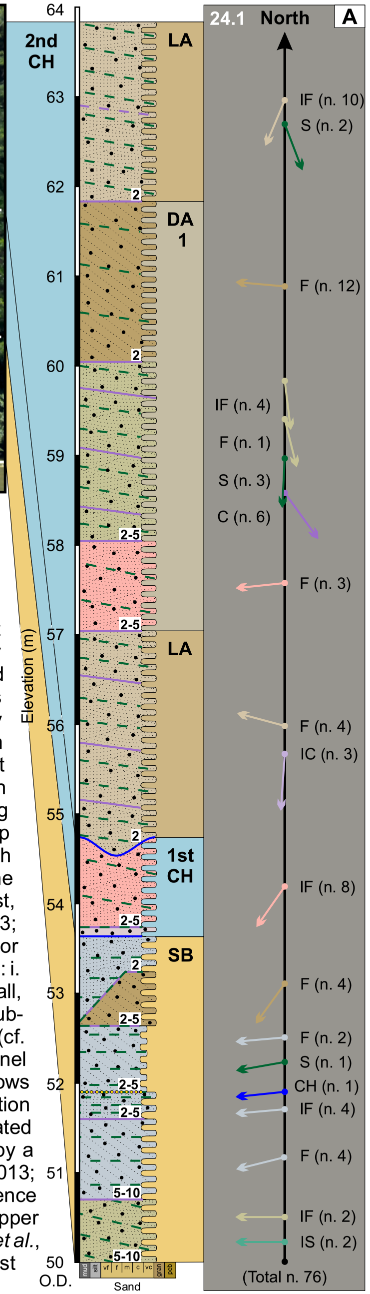


Fig. 4.4 Location 24 - Plumpton Rocks (Outcrop 24.1) - Grid ref: SE 35581 53671 - Elevation: ~50 m O.D. Image view ► 092˚- A. Sedimentary log and palaeocurrents





Interpretation: (Outcrop 24.1) Facies and palaeocurrent data imply deposition was influenced by westerly and south-westerly migrating channel bedforms, below the concave-up second channel base, whereas above the channel base deposition appears to have been influenced by south-westerly to south-easterly palaeocurrents (Fig. 4.4A). Variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events and subsequent net sediment (dune/bar) deposition during waning flow (high and low-flow stages, respectively) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). For example, set thicknesses from 0.05 m (facies Sl-hhs <1.0 m) to 0.60 m (facies Sl-hpx <2.0 m) imply a maximum dune height and channel depth range of between 0.20-2.15 m and 0.55-6.50 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Although, distinct sub-horizontal sets (e.g. facies Sl-hpx <2.0 m) may form components of a larger host dune coset (cf. Haszeldine, 1983b), a coset thickness ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006); for example a coset ~1.80 m thick (facies Sl-hpx <2.0 m) equates to a maximum bar height and channel depth of ~2.85 m and 5.70 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Flood events likely influenced the deposition of facies Ss-lp-lag and Stmx 1.5-3.0 m towards the channel's thalweg (cf. Fidolini *et al.*, 2013; Ghinassi *et al.*, 2014), large bedforms (e.g. Stmx 1.5-3.0 m) generally develop towards a channel's thalweg (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Deposition of large bedforms (e.g. Sl-hpx <2.0 m and Stmx 1.5-3.0 m) may have also influenced the westerly to south-westerly change in palaeocurrent direction and the relatively shallow inclined (<10°) first and fifth-order bounding surface dips (e.g. facies Sl-hhs <1.0 m and Ss-lp-lag) imply the host channel was relatively broad and shallow. Such an interpretation corresponds with McCabe's (1977) observation that distributary channel dips were in the region of ≤10° and Bristow (1987, 1993a) arguing that bounding surfaces, with very low depositional dips, correspond to channels possessing high width to depth ratios. The base of facies Sl-hss-of <1.0 m forms a concave-up (or convex-down) fifth-order bounding surface (Fig. 4.4) which represents an erosive channel incision into facies Stmx 1.5-3.0 m (cf. Miall, 2010b). Such channels may result form: i. a hydraulic gradient during low-flow stage concentrating channel flow towards the thalweg (cf. Bristow, 1987), similar to the formation of bar top chute channels (see Bristow, 1987; Bridge, 2003; Miall, 2010b); and ii. initial diffluence (divergence) around a mid-channel bar of two first, second or third-order channels and subsequent (convergence) confluence which facilitated scouring ahead of the bar tail (cf. Bristow, 1987; Best *et al.*, 2003; Bridge, 2003). Conceivably, the erosive channel may represent either a constrained first-order channel (through reduced channel flow) or subordinate second or third-order channels (cf. Coleman, 1969; Bristow, 1987; Bridge, 2003; Miall, 2010b and references there in). Therefore, facies Sl-hss-of <1.0 m may represent: i. lateral migration influenced by high-flow stage which facilitated the formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Ghinassi et al., 2009; Miall, 2010b; Reesink *et al.*, 2014); or ii. mid-channel bedform migration, probably within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014), where discrete sub-horizontal sets formed coset components of either a small-scale unit bar (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009), or larger host dune (cf. Haszeldine, 1983b). Sambrook Smith *et al.* (2006) observed unit bars migrating upstream and downstream of, and adjacent to, the flank of a mid-channel compound bar. Further, topographic lows adjacent to channel margins, during low-flow stage, may constrain falling-stage currents similar to topographic lows between channel bars (sensu Collinson, 1970; cf. Reesink *et al.*, 2014), thereby facilitating lateral-accretion along the channel margin, comparable to deposition along bar margins (sensu Collinson, 1970, 1996), whilst probably migrating towards the channel thalweg (cf. Best *et al.*, 2003). Overall, the initial facies associated with Outcrop 24.1, up to the concave-up channel base, probably represent channel fill deposits concomitant with a relatively broad channel influenced by a variable flow depth (≤6.50 m) and a predominantly west to south-westerly palaeocurrent. Although lag deposits may denote channel thalwegs (Fidolini *et al.*, 2013; Ghinassi *et al.*, 2014) and the base of compound bars (Ashworth *et al.*, 2011) for example, such deposits may also define a channel base and channel fill sequence (Ashworth *et al.*, 2011). Hence, the relatively horizontal lag deposit and initial facies of Stmx 1.5-3.0 m may denote a flat channel base (Fig. 4.4), whereas the upper deposit of Stmx 1.5-3.0 m may form basal facies relating to a mid-channel bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Mumpy *et al.*, 2007), the subsequent south-easterly to westerly palaeocurrents (Elements DA1 and LA, Fig. 4.4A) may denote accretion of individual unit bars onto a host compound bar (macroform) through lateral and downstream-accretion (cf. Bridge & Lunt, 2006) whilst the main bar migrated downstream.

Fig. 4.5 Location 24 - Plumpton Rocks
Metrics Plot and Palaeocurrent Azimuths

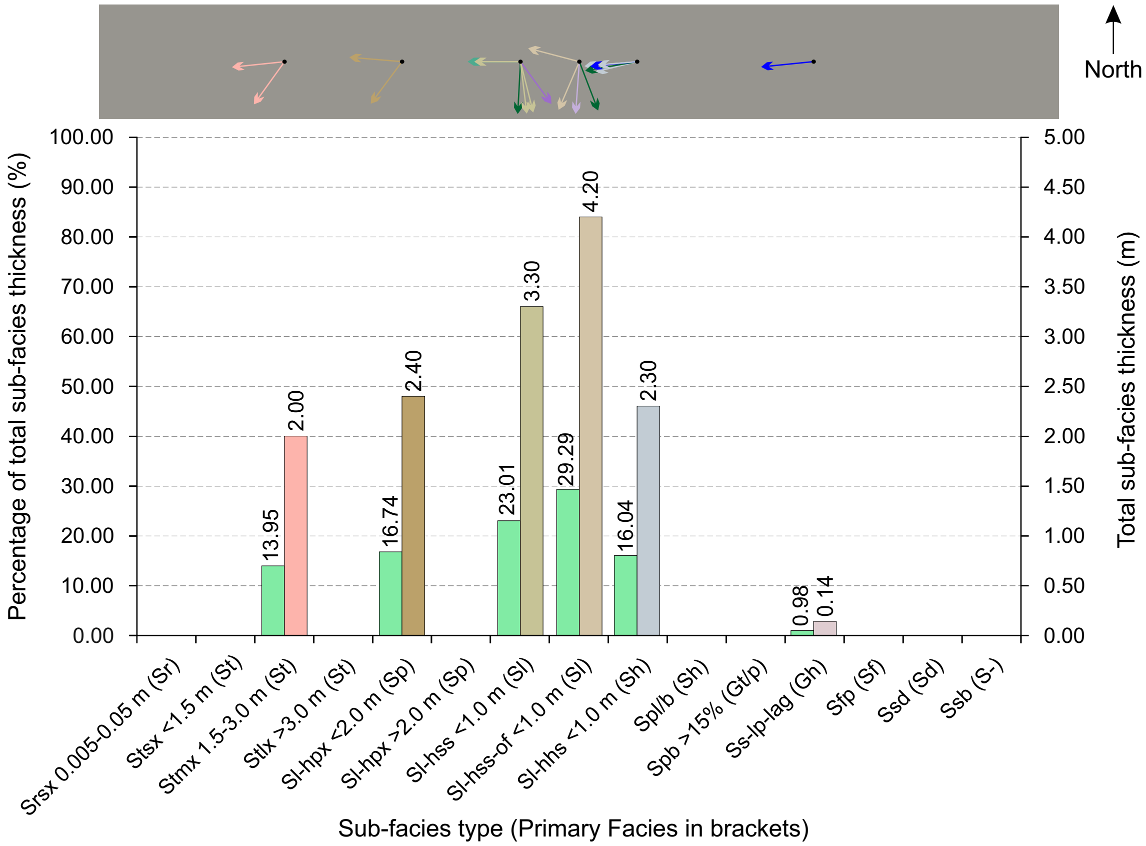


Fig. 4.6 Location 24 - Plumpton Rocks
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

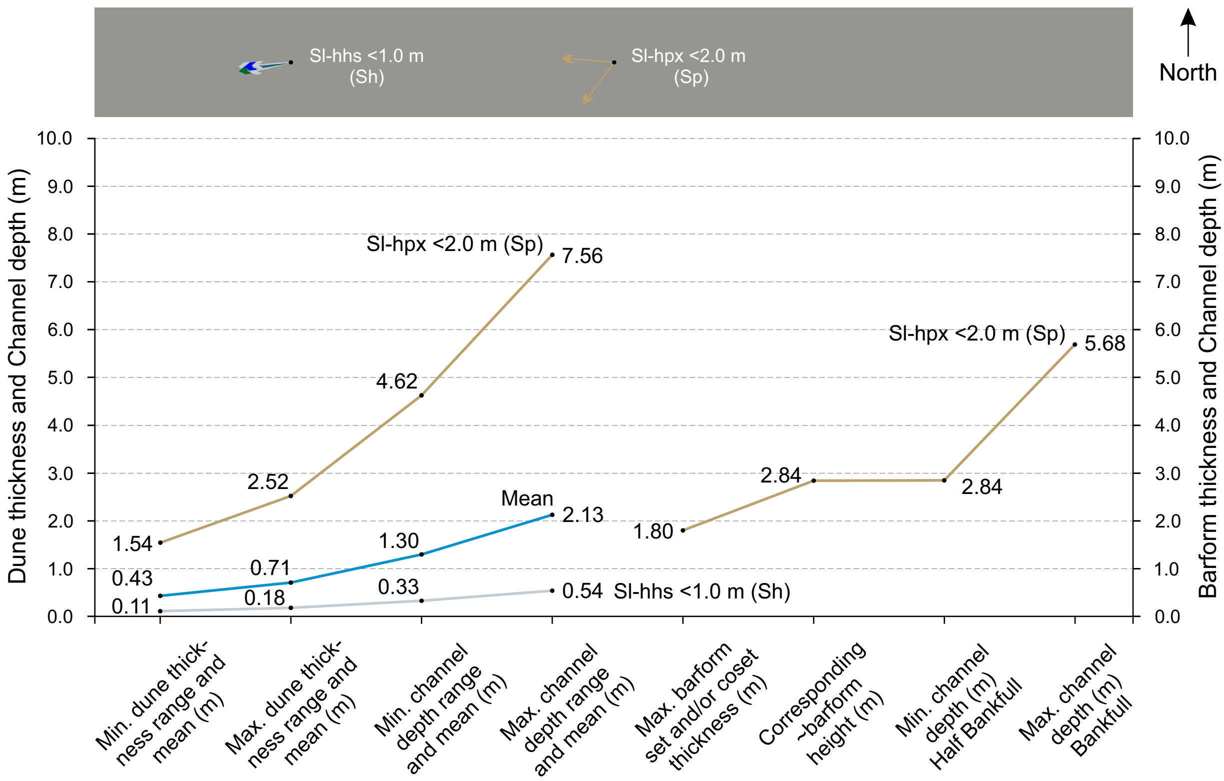
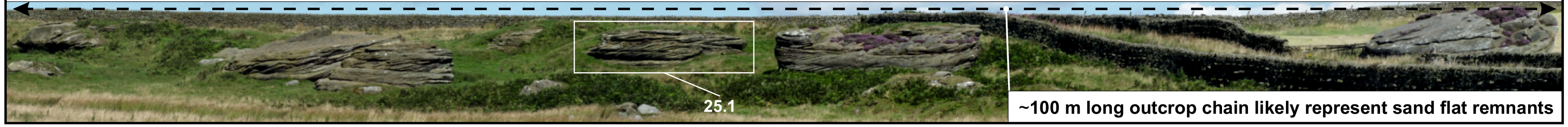
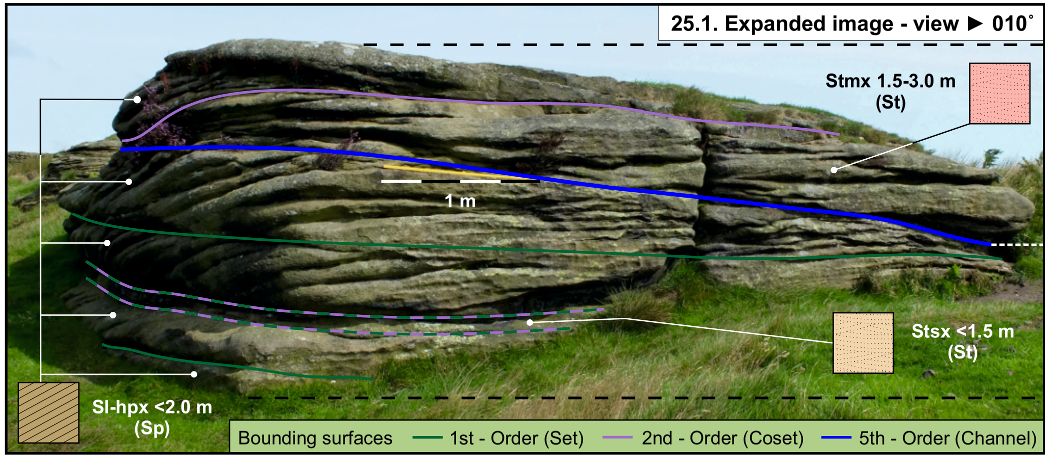
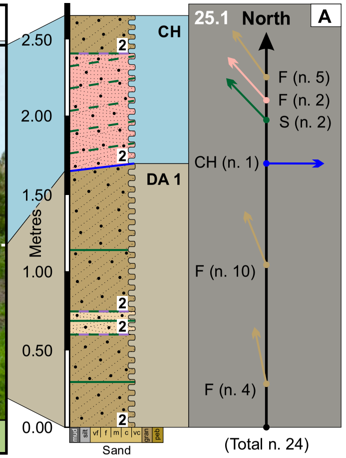


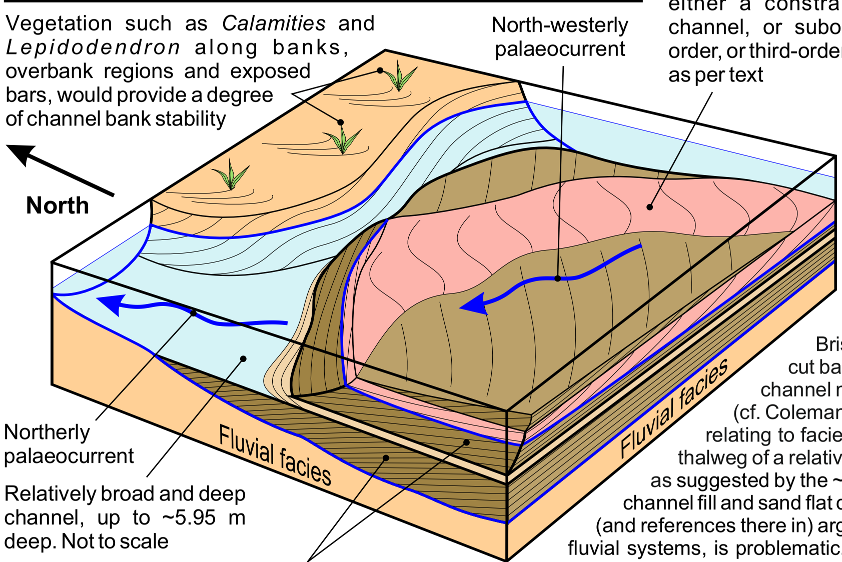
Fig. 4.4 Location 25 - High Wild Carr Farm - Old Crags (Outcrop 25.1) - Grid ref: SE 17053 66178 - Elevation: ~302 m O.D. - Main view ► 040˚ - A. Sedimentary log and palaeocurrents







B. Schematic representation of Sand Flat and Channel sequence



Interpretation: (Outcrops 25.1) Facies and palaeocurrent data imply deposition was influenced by northerly migrating channel bedforms, below the incised channel base and more north-westerly palaeocurrents above the channel base (Figs 4.4A and B). The variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events and subsequent net sediment (dune/bar) deposition during waning flow (high- and low-flow stages, respectively) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). For example, set thicknesses from 0.05 m (facies Stsx <1.5 m) to 0.55 m (facies Sl-hpx <2.0 m) imply a maximum dune height and channel depth range of between 0.20-2.00 m and 0.55-5.95 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Facies Sl-hpx <2.0 m probably formed towards the channel's thalweg where large bedforms generally develop (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Facies Stsx <1.5 m may represent: i. an overall reduction in channel depth which facilitated downstream and/or lateral-accretion of 3D mesoforms within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink *et al.*, 2014); ii. a component of vertical-accretion along a sand flat surface (cf. Cant & Walker, 1976, 1978), primarily due to dune stacking and shallow flow conditions above the sand flat, similar to vertical-accretion along bar tops (cf. Best *et al.*, 2003; Bridge & Lunt, 2006); iii. repeated bedform migration, probably as a train of dunes along a bar surface (Miall, 2010b; cf. Ashworth *et al.*, 2011). Further flood events would have amplified the rivers flow and sediment load capacity, thereby facilitating deposition of additional facies of Sl-hpx <2.0 m. The base of facies Stmx 1.5-3.0 m forms a shallow (~6°) inclined erosive channel incision into facies Sl-hpx <2.0 m, thereby generating a fifth-order bounding surface (cf. Miall, 2010b). Such channels may form as a result of a hydraulic gradient during low-flow stage concentrating the flow towards the channel thalweg (cf. Bristow, 1987), similar to the formation of a bar top chute channel (cf. Bristow, 1987; Bridge, 2003; Miall, 2010b). Similarly, the partial erosive channel outline may be related to a cut bank thalweg profile associated with a curved channel section (cf. Bridge, 2003). Conceivably, the erosive channel may represent either a constrained first-order channel, subordinate second-order, or third-order channel (cf. Coleman, 1969; Bristow, 1987; Bridge, 2003; Miall, 2010b and references there in). The relatively horizontal sets relating to facies Stmx 1.5-3.0 m likely represent downstream migration and accretion of 3D mesoforms towards the thalweg of a relatively broad and shallow channel (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014), as suggested by the ~6° first and fifth-order set and channel inclines, respectively. Overall, Outcrop 25.1 probably represents channel fill and sand flat deposits, rather than migratory mid-channel bars; although Skelly *et al.* (2003) and Ashworth *et al.* (2011) (and references there in) argue that the distinction between compound bar and adjacent channel fill core deposits, in sandy braided fluvial systems, is problematic. Further, Leeder (1982) argues that the preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and the coarse to very coarse-grained sandstone component coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems.

Fig. 4.5 Location 25 - High Wild Carr Farm (Old Crags)
Metrics Plot and Palaeocurrent Azimuths

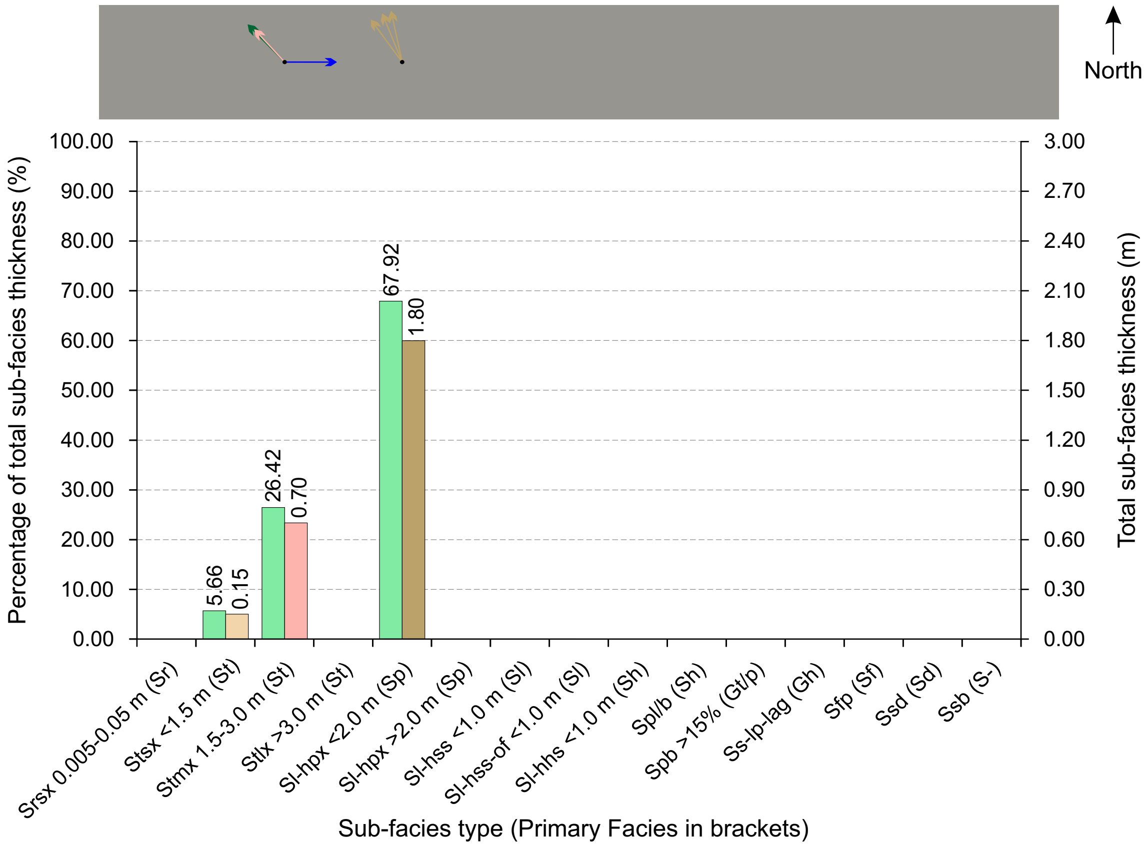


Fig. 4.6 Location 25 - High Wild Carr Farm (Old Crags)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

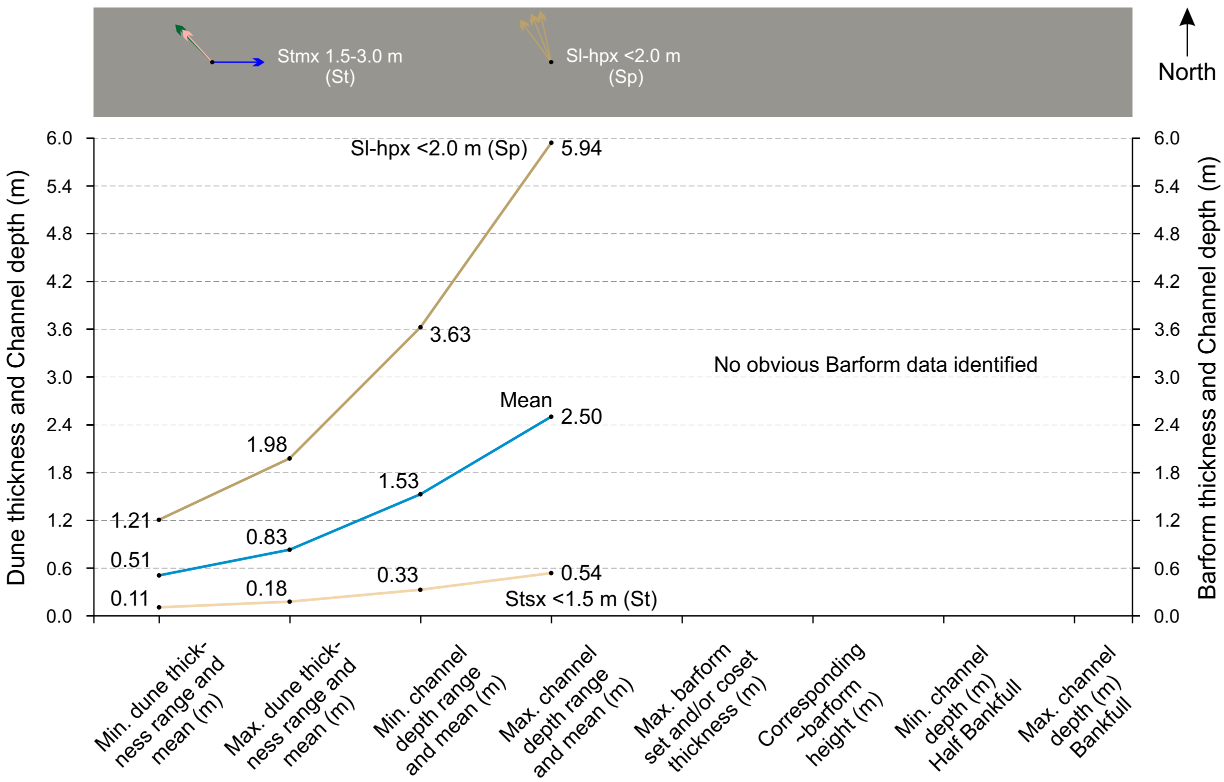
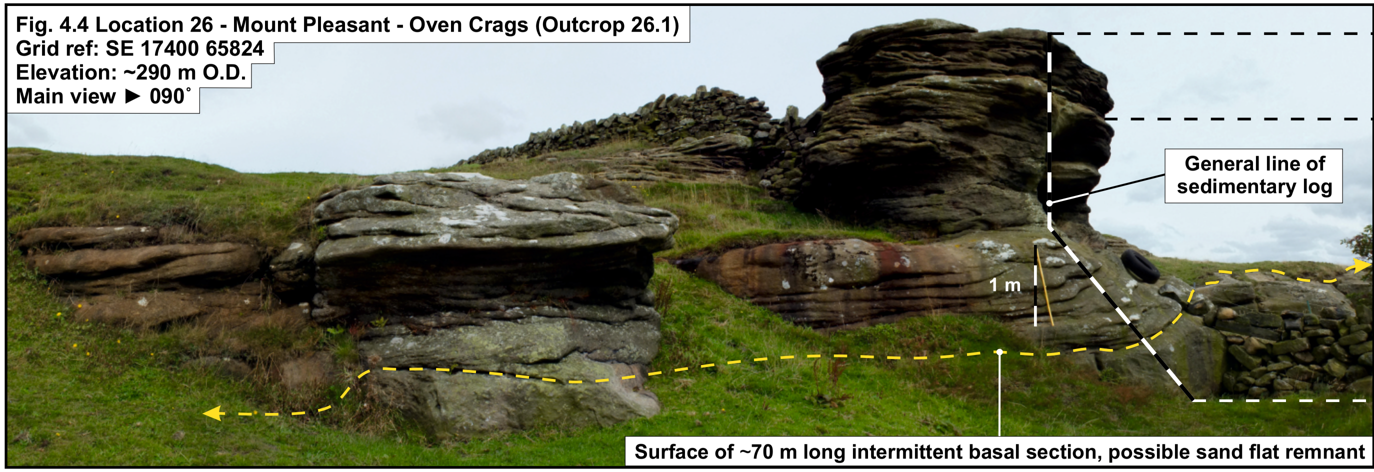
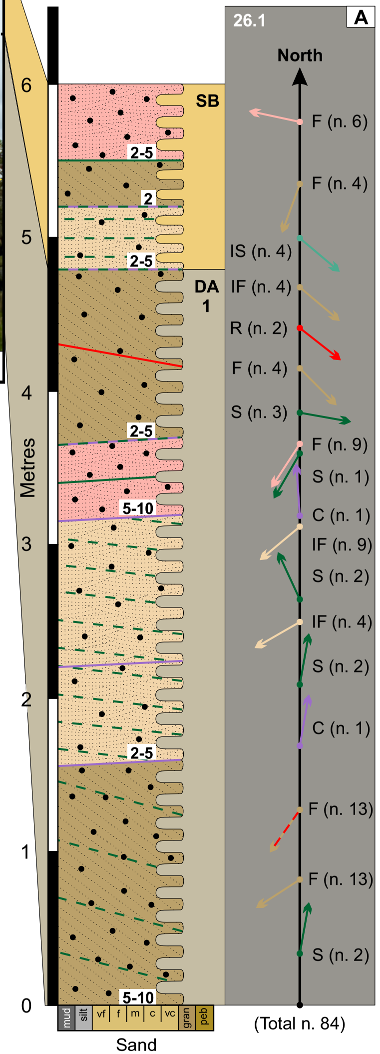


Fig. 4.4 Location 26 - Mount Pleasant - Oven Crags (Outcrop 26.1)
Grid ref: SE 17400 65824
Elevation: ~290 m O.D.
Main view ▶ 090˚



A. Sedimentary log and palaeocurrents



Interpretation: (Outcrops 26.1) Facies and palaeocurrent data imply deposition was influenced by mainly south-westerly and south-easterly migrating bedforms, although palaeocurrents are generally variable (Fig. 4.4A). The variable thicknesses of individual sets and cosets evidence variable flow depths and sediment influx, likely facilitated by flood events and subsequent net sediment (dune/bar) deposition during waning flow (high and low-flow stages, respectively) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). For example, set thicknesses from 0.05 m (facies Stsx <1.5 m) to 0.50 m (facies Stmx 1.5-3.0 m) imply a maximum dune height and channel depth range of between 0.20-1.80 m and 0.55-5.40 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). As set thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006), a ~1.10 m thick set (facies Sl-hpx <2.0 m) equates to a maximum bar height and channel depth of ~3.30 m and 6.60 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Initial facies of Sl-hpx <2.0 m are mainly constructed from repeated grain flow avalanche deposits (0.02-0.03 m thick foresets, see Smith, 1972; Reesink & Bridge, 2007, 2009) that likely represent downstream migration and accretion of 2D mesoforms. Such mesoforms probably developed towards the channel thalweg; large dunes tend to develop towards deeper channel thalweg regions within relatively broad/deep channels (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Leclair, 2011; Reesink *et al.*, 2014). Such facies are also associated with downstream migration and net aggradation of: i. longitudinal bars (Ghinassi *et al.*, 2009); ii. unit bars (cf. Bridge & Lunt, 2006; Ashworth *et al.*, 2011), although such bar heights coincide with dune heights (Ashworth *et al.*, 2011); iii. transverse bars with angular foreset contacts, generated as a result of low fluid and low sediment discharge, (cf. Smith, 1972; Hein & Walker, 1977; Collinson *et al.*, 2006); or iv. a sand flat sequence (cf. Cant & Walker, 1976, 1978). The 14°-18° dip and 010° azimuth relating to facies Sl-hpx <2.0 m may be attributed to syn-sedimentary tectonic subsidence along the North Craven Fault or sediment migration over a much slower moving host bedform (cf. Haszeldine, 1983a, 1983b; Collinson *et al.*, 2006). Conversely, deposition may have been related to bar top vertical and/or upstream-accretion associated with the bar head and/or mid-bar section of a mid-channel bar, primarily due to dune stacking (cf. Bristow, 1993a; Best *et al.*, 2003; Bridge & Lunt, 2006; Mumpy *et al.*, 2007); also, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and subject to the inclination of their host bed most sets will climb at a similar angle (Leeder, 1982). Deposition of facies Stsx <1.5 m may represent: i. bar top vertical and/or upstream-accretion of small-scale trough cross-bedding associated with the bar head and/or mid-bar section of a mid-channel bar, primarily due to dune stacking and relative shallow flow depth above the host bar (cf. Best *et al.*, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Mumpy *et al.*, 2007); ii. downstream and/or lateral-accretion of 3D mesoforms within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.*, 2009; Miall, 2010b; Reesink *et al.*, 2014); or iii. sand flat components relating to a channel fill sequence (cf. Cant & Walker, 1976, 1978). Stacked sets separated by first-order set boundaries indicate repeated bedform migration, possibly as a train of dunes over a large bar surface (Miall, 2010b; cf. Ashworth *et al.*, 2011) and the subcritical set angles imply that they migrated over a stalled, or slower moving, host bedform (cf. Haszeldine, 1983a, 1983b; Collinson *et al.*, 2006). Facies Stmx 1.5-3.0 m likely represent downstream migration and accretion of 3D mesoforms that may have developed towards the thalweg of a relatively broad and deep channel (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014), probably generated by flood events (see above). Such flood events likely resulted in palaeocurrent transferal towards the southeast and deposition of a ~1.10 m thick set of facies of Sl-hpx <2.0 m during falling-flow stage (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011), which likely represents downstream migration and accretion of a unit bar (see above) (cf. Bridge & Lunt, 2006; Ashworth *et al.*, 2011). Equally, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. The overlying succession (facies Stsx <1.5 m, Sl-hpx <2.0 m and Stmx 1.5-3.0 m) denote an initial decrease and subsequent gradual increase in channel depth and flow capacity (see above facies interpretations). Overall, Outcrop 26.1 likely represents downstream-accretion and channel fill sequence consisting of individual unit bars and dunes punctuated by flood events and a shifting fluvial channel, as indicated by the south-westerly to south-easterly and return to westerly palaeocurrent variations. An overall reduction in the observed palaeocurrent, coset and set azimuth dips from 18° (facies Sl-hpx <2.0 m) to 06° (facies Stsx <1.5 m) and 04° (facies Stmx 1.5-3.0 m), suggests that the possible effect of any previous tectonic subsidence, or upstream-accretion, may have been mitigated by subsequent sediment deposition and the ≤10° first and second-order bounding surface dips (facies Sl-hpx <2.0m, Stsx <1.5 m, and Stmx 1.5-3.0 m) likely correspond to a channel possessing a high width to depth ratio (Bristow, 1993a).

Fig. 4.5 Location 26 - Mount Pleasant (Oven Crags)
Metrics Plot and Palaeocurrent Azimuths

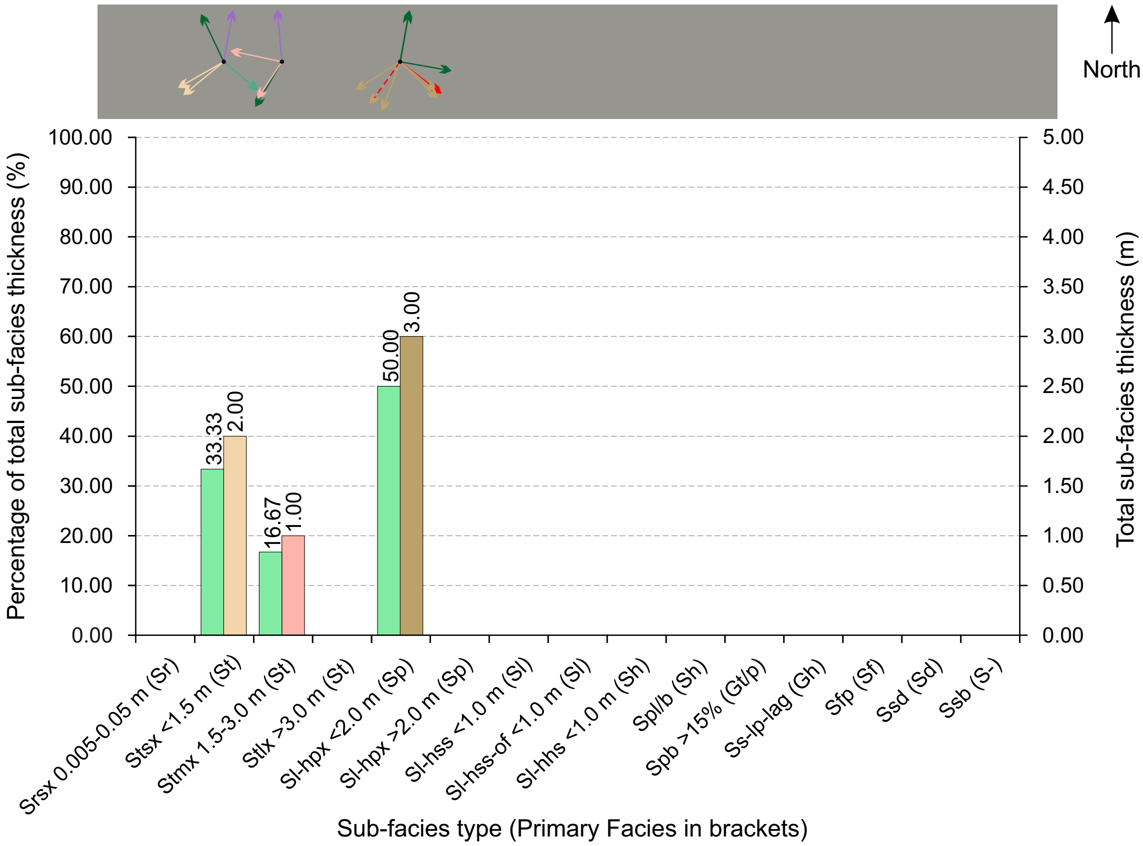


Fig. 4.6 Location 26 - Mount Pleasant (Oven Crags)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

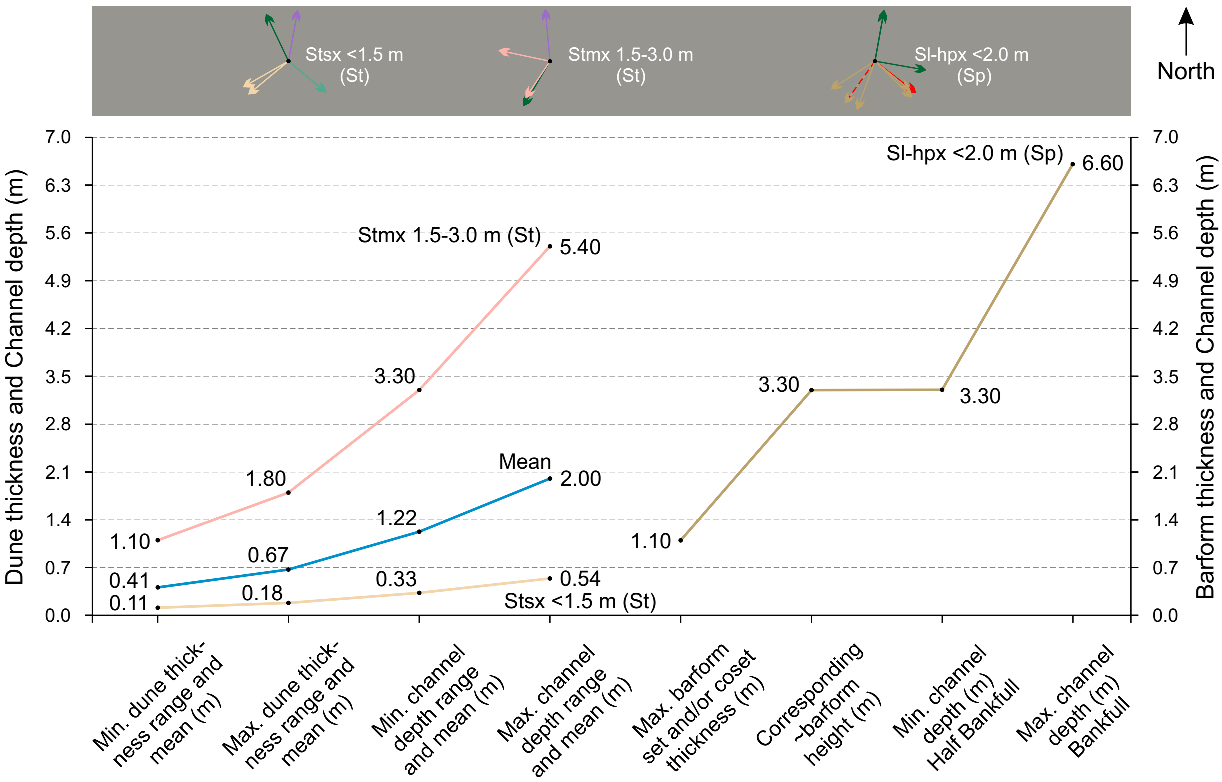
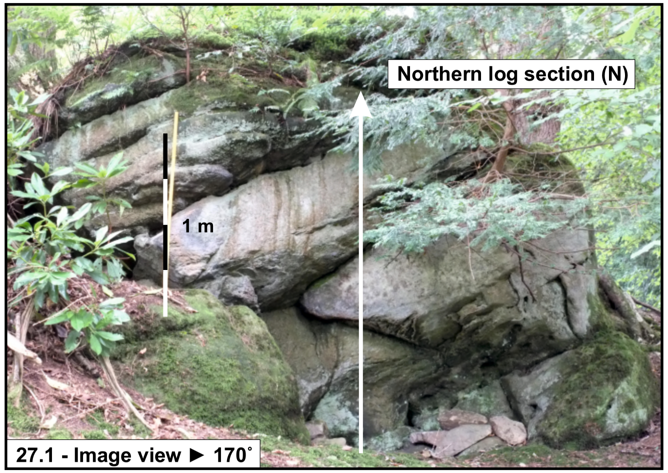
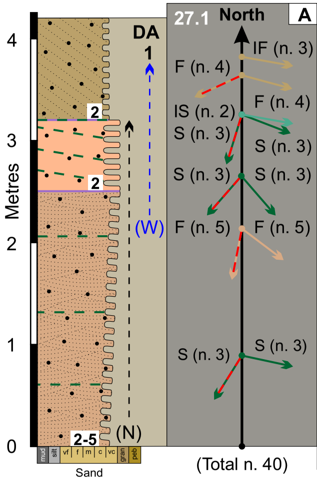
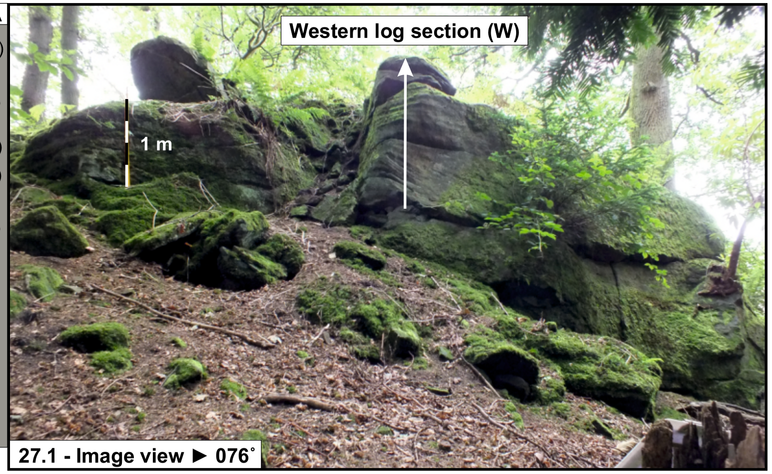


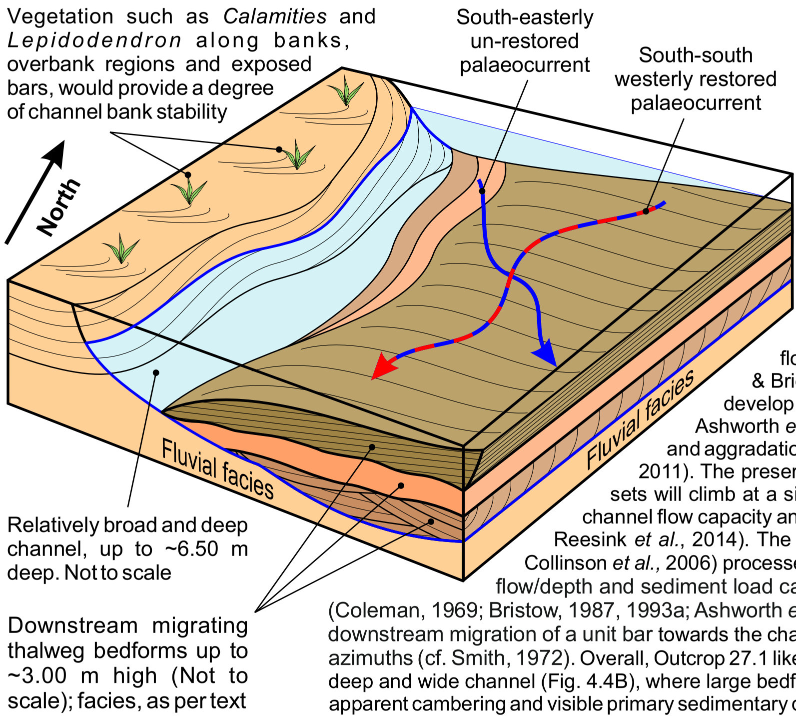
Fig. 4.4 Location 27 - Hindmes Wood (Outcrops 27.1-27.2) - Grid ref's: SE 14955 64929 and SE 14884 64963 - Elevation: 182 m - 192 m O.D. - A. Sedimentary log and palaeocurrents







B. Schematic representation of thalweg bedform migration/accretion



Interpretation: (Outcrop 27.1) Given the proximity (~80.0 m) of the Libishaw Sandstone (Outcrop 27.2, not illustrated) to the Lower Brimham Grit (Outcrop 27.1) and the likely hood that Outcrop 27.1 and 27.2 are located to the south and north of the North Craven Fault, respectively, both outcrops have probably been subjected to tectonic tilting, as indicated by the sub-horizontal Libishaw Sandstone beds. Initial palaeocurrent field data obtained from Outcrop 27.1 imply that deposition was influenced by south-easterly palaeocurrents (Fig. 4.4A). By adopting the 26˚ dip and 084˚ azimuth relating to the Libishaw Sandstone, data collated from Outcrop 27.1 were restored using stereographic projection. The restored data show palaeocurrent trends shift 90 degrees westwards, indicating that deposition was likely influenced by variable south to south-westerly palaeocurrents (Fig. 4.4A). Coset and set thicknesses suggest variable channel depths and sediment input; a maximum set thickness of ~0.60 m (facies Stlx >3.0 m) imply a maximum dune height and channel depth of ~2.20 m and ~6.50 m, respectively (cf. Reesink & Bridge, 2009; Leclair, 2011). As set thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006), a ~1.00 m thick set (facies Sl-hpx <2.0 m) equates to a maximum bar height and channel depth of ~3.00 m and 6.00 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Similarly, Sambrook Smith *et al.* (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. The scale of the cross-bedding and coarsening-up sequence relating to facies Stlx >3.0 m suggest medium to large-scale 3D mesoforms prograded downstream influenced by high-flow stage which facilitated migration and formation of down-climbing dunes (cf. Bristow, 1988, 1993a; Reesink & Bridge, 2009; Ghinassi, 2011) towards the thalweg of a relatively broad and deep channel; large dunes tend to develop towards deeper channel thalweg regions within relatively broad/deep channels (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Such facies were likely generated by flood events with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb at a similar angle/dip to that of their host bed (Leeder, 1982). Facies Ssb likely represent a sudden decrease in channel flow capacity and rapid deposition, influenced by waning flow and channel fill (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). The small to medium pebble lags defining Ssb sets likely represent scouring (Miall, 2010b) or winnowing (cf. Collinson *et al.,* 2006) processes. A further flood event likely influenced deposition of facies Sl-hpx <2.0 m, through increased channel flow/depth and sediment load capacity, with sediment migration and aggradation influenced by high and low-flow stages, respectively (Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). The size of cross-bedding (~1.00 m thick set) and relatively uniform foreset azimuths implies downstream migration of a unit bar towards the channel thalweg (see above), rather than a transverse bar (2D macroform) which possess variable foreset azimuths (cf. Smith, 1972). Overall, Outcrop 27.1 likely represents downstream migration/accretion and channel fill sequence relating to the thalweg of a relatively deep and wide channel (Fig. 4.4B), where large bedforms had the potential to develop (Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014); the apparent cambering and visible primary sedimentary detail (e.g. sets) imply influence of post rather than syn-sedimentary tectonic activity.

Fig. 4.5 Location 27 - Hindmes Wood
Metrics Plot and Palaeocurrent Azimuths

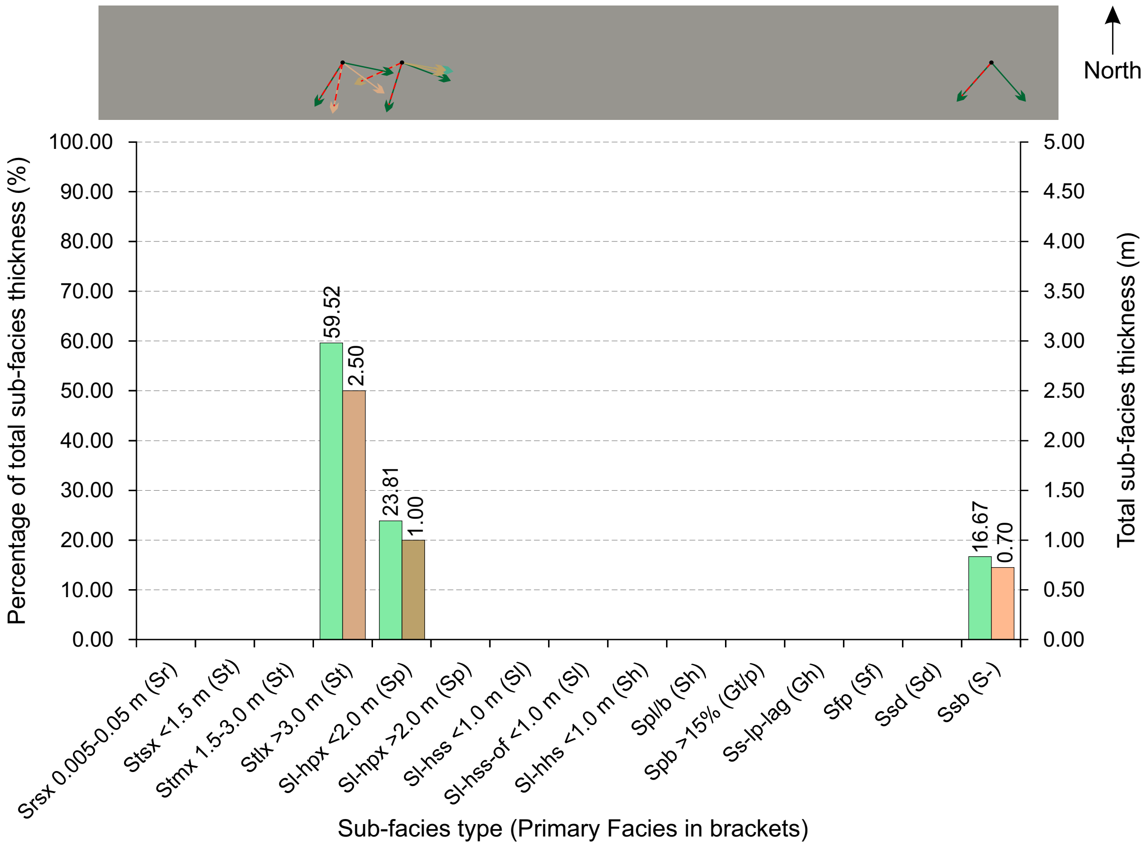


Fig. 4.6 Location 27 - Hindmes Wood
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

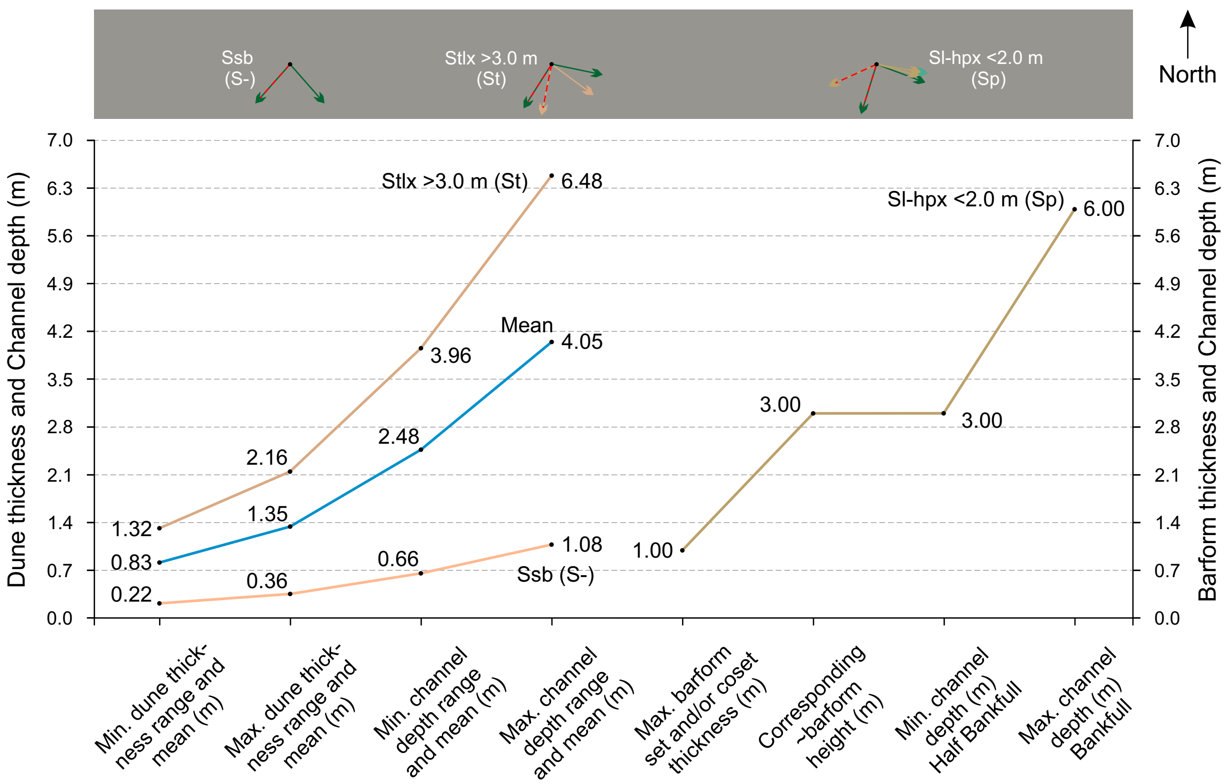
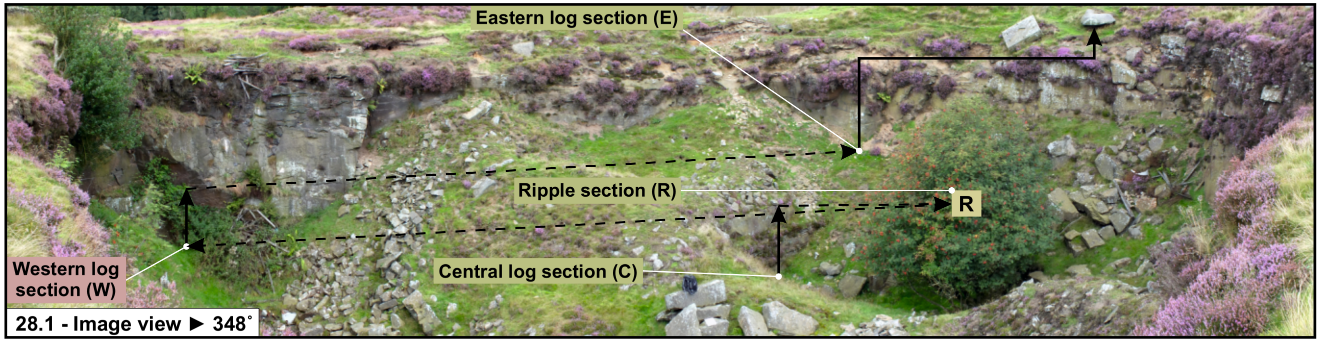
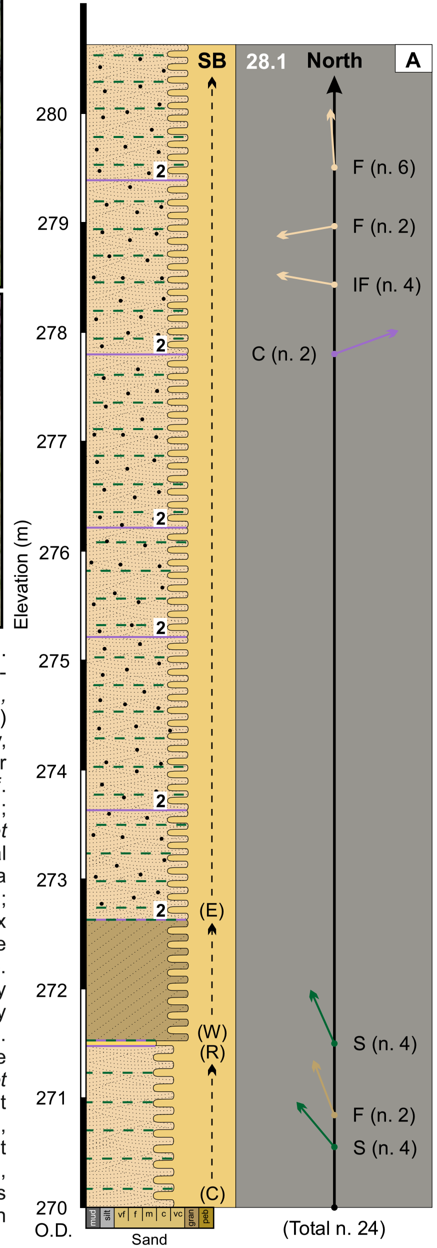


Fig. 4.4 Location 28 - Low Moor (Disused Quarry - Outcrop 28.1) - Grid ref: SE 14570 63744 - Elevation: ~270 m O.D.



A. Sedimentary log and palaeocurrents



Interpretation: (Outcrops 28.1) Palaeocurrent data imply deposition was influenced by mainly north-westerly migrating channel bedforms (Fig. 4.4A). Variable set thicknesses of 0.10-0.25 m (facies Stsx <1.5 m) suggest variable flow capacity and sediment input likely facilitated by flood events (high-flow stage) and subsequent net sediment deposition during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). Set thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006), therefore a ~1.10 m thick set (facies Sl-hpx <2.0 m) equates to a maximum bar height and channel depth of ~3.30 m and 6.60 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Similarly, Sambrook Smith *et al*. (2006) interpret sets >0.5 m, which possess inclined (i.e. ≤ angle-of-repose) cross-stratification, as a consequence of bar migration. Facies Stsx <1.5 m may represent: i.downstream migration and accretion of 3D mesoforms within a relatively deep (up to 2.70 m deep; cf. Reesink & Bridge, 2009; Leclair, 2011) (Fig. 4.6) thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.,* 2009; Miall, 2010b; Reesink *et al.,* 2014), influenced by waning flow, net sediment aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al*., 2011; Reesink *et al*., 2014); ii. migratory bedforms that developed on the surface of a larger sand flat (cf. Cant & Walker, 1976, 1978); iii. a series of distinct depositional episodes (cf. Collinson *et al.,* 2006) of assembled sets divided by first-order set boundaries which indicate repeated bedform migration probably as a train of dunes (dune stacking) which may have formed components of a channel bar top (cf. Bristow, 1993b; Best *et al*., 2003; Bridge & Lunt, 2006; Mumpy *et al*., 2007; Miall, 2010b; Ashworth *et al*., 2011); iv. and/or the latter stages of a channel fill sequence (cf. Reesink *et al*., 2014). Facies Srsx 0.005-0.05 m is consistent with either upper channel fill (Bridge & Lunt, 2006; Ashworth *et al.,* 2011), or bar top (Bristow, 1993b; Best *et al*., 2003; Bridge & Lunt, 2006; Mumpy *et al*., 2007), deposition related to shallow channel flow conditions and low-flow stage deposition (Bridge & Lunt, 2006). Conversely, facies Sl-hpx <2.0 m (see above) suggests in channel sediment migration and ensuing net sediment deposition (aggradation) facilitated by a flood event (high-flow stage) and waning flow (low-flow stage), respectively (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011), probably towards the channel thalweg where larger bedforms generally develop (cf. Reesink & Bridge, 2009; Ashworth *et al*., 2011; Reesink *et al*., 2014). Horizontal striations (slickensides) running along the western quarry face and possible flower structures indicate the presence of a transverse, strike slip or wrench fault trending 130˚-310˚ (cf. Arthurton, 1983; Dooley & Schreurs, 2012; Chemenda *et al*., 2016; Marinin & Tveritinova, 2012; Bhakuni *et al*., 2017) (Fig. 4.4.28). Positive and negative flower structures are indicative of horizontal stress orientated perpendicular, or parallel, to the basement fault and transverse shortening/convergence (transpression) or transverse extension/divergenceare (transtension), respectively (Dooley & Schreurs, 2012). The perpendicular orientation of the transverse fault to the North Craven Fault located ~500 m to the northwest and the absence of soft sediment deformation, suggest that the outcrop was probably subjected to post- rather than syn-sedimentary tectonic convergence (transpression). Overall, Outcrop 28.1 may represent an upper channel fill sand body sequence, rather than a migratory mid-channel bar sequence; although mid-channel bars may also be interpreted as channel fill components, Skelly *et al*. (2003) and Ashworth *et al*. (2011) (and references there in) argue that the distinction between compound bar and adjacent channel fill core deposits, in sandy braided fluvial systems, is problematic.

Fig. 4.5 Location 28 - Low Moor (Disused Quarry)
Metrics Plot and Palaeocurrent Azimuths

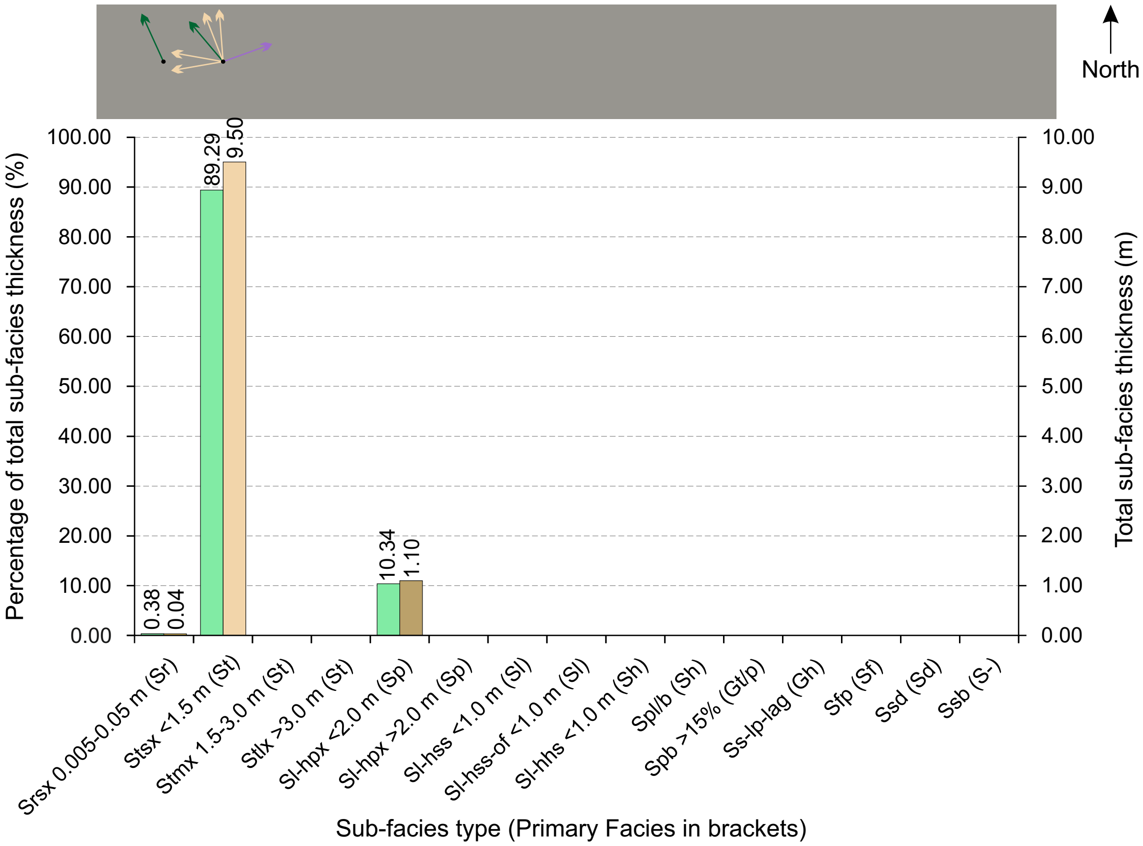


Fig. 4.6 Location 28 - Low Moor (Disused Quarry)
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

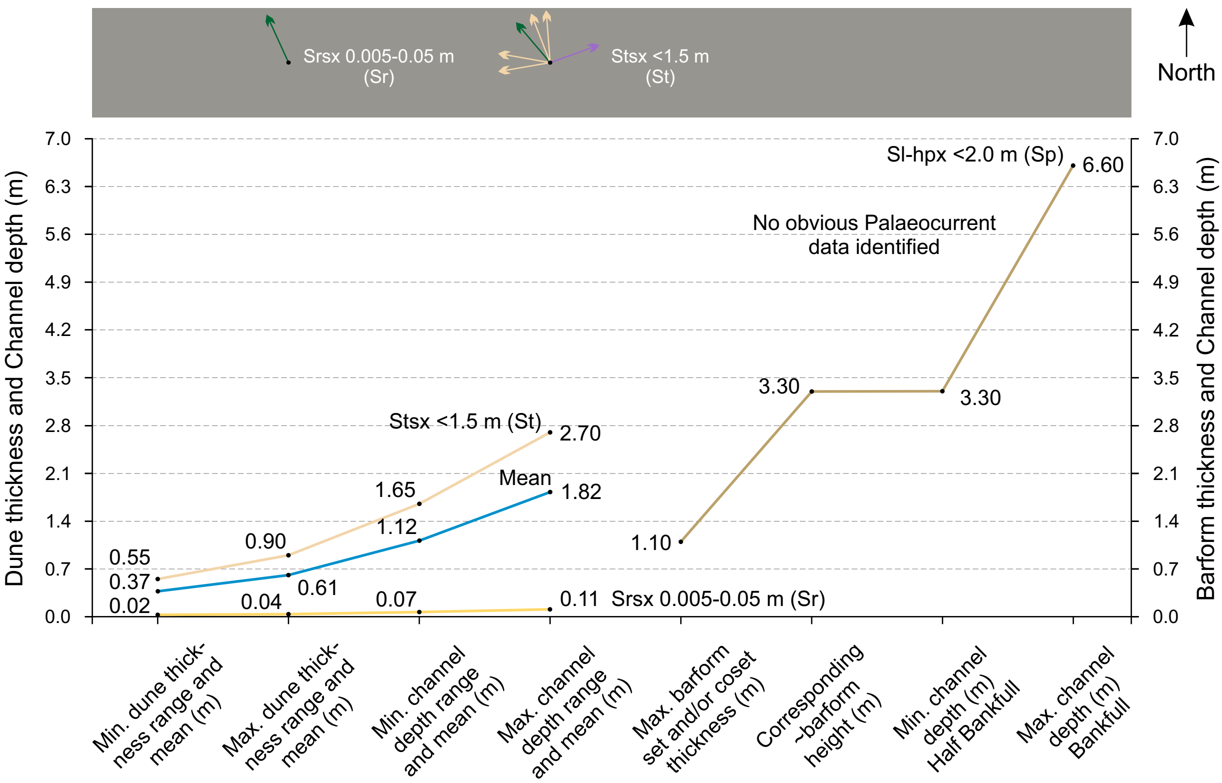
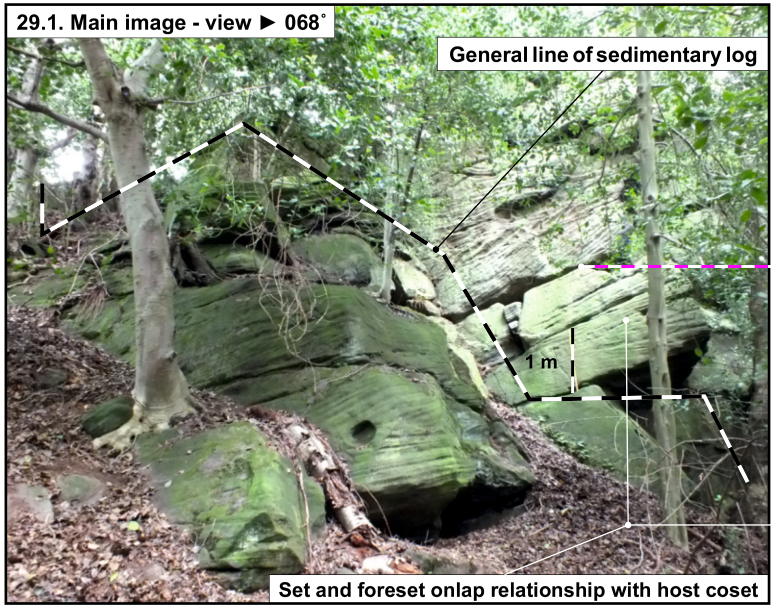
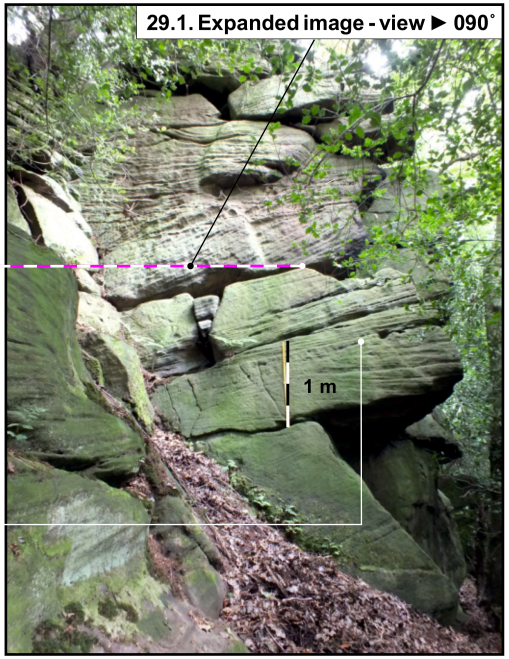
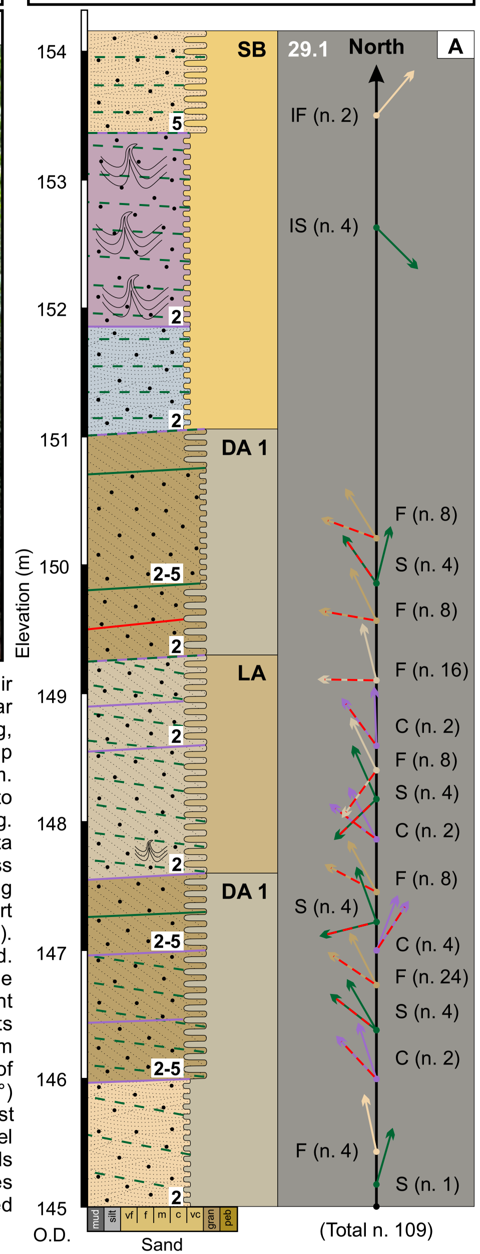


Fig. 4.4 Location 29 - Knox Wood (Outcrop 29.1) - Grid ref: SE 19173 63871 - Elevation: ~145 m O.D.





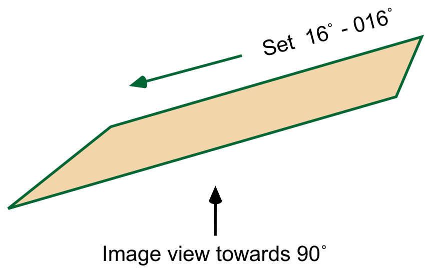
A. Sedimentary log and palaeocurrents



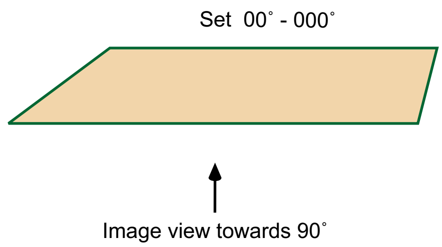
Interpretation: (Outcrops 29.1) Palaeocurrent field data imply that deposition was mainly influenced by north-westerly palaeocurrents, with limited north-easterly and south-easterly bedform migration (Fig 4.4A). Although not conclusive, several set and foreset data appear to possess onlap relationships with their underlying coset boundary, rather than more consistent offlap/downlap relationships (Fig 4.4B[1-6]). Collectively, with the cosets and sets that appear to possess a northerly dip direction and 38° foreset dips, these observations suggest the lower sequence of Outcrop 29.1 (up to, but not including, facies Sl-hhs <1.0 m) may have been influenced by syn-sedimentary tectonic activity along the North Craven Fault, possibly reflected by the 16° dip and 016° azimuth relating to the basal facies of Stsx <1.5 m, not evident in the upper sequence above, and including, facies Sl-hhs <1.0 m. Therefore, data relating to the lower sequence were restored through stereographic projection relative to the 16˚ dip and 016˚ azimuth relating to facies of Stsx <1.5 m. The restored data adopt more variable north-easterly to south-westerly palaeocurrents (Fig 4.4B[1-3]), offlap contacts (e.g. facies Sl-hss-of <1.0 m) and the apparent northerly dip (e.g. facies Sl-hpx <2.0 m) is restored to the horizontal (Fig 4.4B[4-6]). The restored data appears consistent with that of previous outcrops; hence, the restored data was adopted when interpreting Outcrop 29.1. A maximum set thickness of ~0.90 m (facies Sl-hpx <2.0 m) implies a maximum dune height and channel depth of ~3.25 m and ~9.70 m, respectively (cf. Leclair, 2011) (Fig 4.6). Conversely, variable set thicknesses of ~0.10 m to ~0.30 m indicate deposition was likely influenced by varying amounts of sediment transport and input, probably governed by minor flood events and related variable channel depths of ~0.65 m to ~3.25 m, respectively (cf. Leclair, 2011). Overall, Outcrop 29.1 may represent a remnant of a compound bar (3D macroform) likely influenced by tectonic activity, evidenced by facies Ssd. Such bars are constructed from component unit bar deposits consisting of simple inclined (mainly <10°, but may be up to 35°) small to large-scale sets, which may show a vertical reduction in dune/set height correlated to a decrease in channel depth, the deposits may also display no significant vertical shift in grain size (cf. Bridge & Lunt, 2006). These traits are consistent with the facies associated with Outcrop 29.1, which likely represents an amalgamation of several unit bar components. The variable coset, set and foreset palaeocurrent azimuths may also evidence the downstream migration and/or lateral-accretion of a compound bar; the preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and subject to the inclination of their host bed most sets will climb at a similar angle (Leeder, 1982). Further, the shallow inclined (≤12°) bounding surface and/or foreset dips, evident in certain facies e.g. Stsx <1.5 m, Sl-hpx <2.0 m and Sl-hss-of <1.0 m, likely denote that the host channel was relatively broad and varied in depth. Such an interpretation corresponds with McCabe's (1977) observation that distributary channel dips were in the region of ≤10° and Bristow (1987, 1993a) arguing that bounding surfaces, with very low depositional dips, correspond to channels possessing high width to depth ratios. Further, the relatively coarse-grained to granular sandstone texture associated with Outcrop 29.1 coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003).

B^{1}. Tectonically tilted bedding - Facies Stsx <1.5 m (Set data). Observations suggest that the basal facies may have been subjected to tectonic tilting of 16° towards an azimuth of 016°. **B^{4}.** Basal facies Stsx <1.5 m subjected to tectonic tilting of 16° towards an azimuth of 016° restored to horizontal plain by way of stereographic projection.

B^{1}.

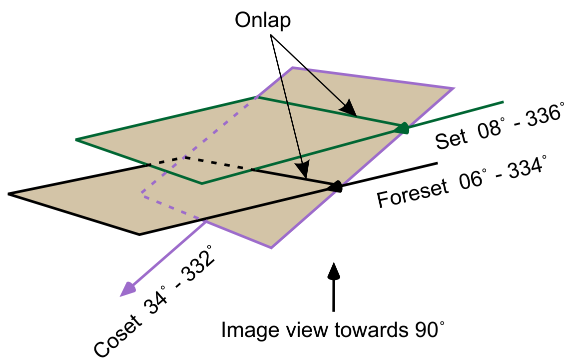


B^{4}.

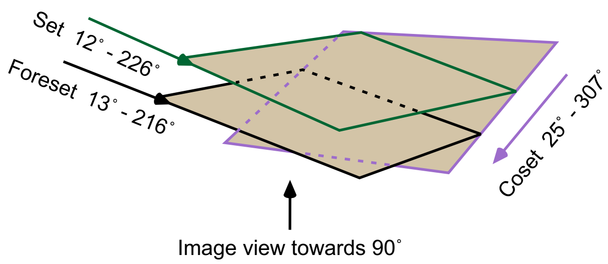


B^{2}. Tectonically tilted bedding - Facies Sl-hss-of <1.0 m. Sets and foresets appear to possess onlap type relationship with host coset i.e. set-foreset dip < coset dip. **B^{5}.** Restored field data relating to facies Sl-hss-of <1.0 m; data restored relative to basal facies Stsx <1.5 m now exhibit coset, set and foreset data consistent with an offlap-downlap relationship and lateral accretion.

B^{2}.

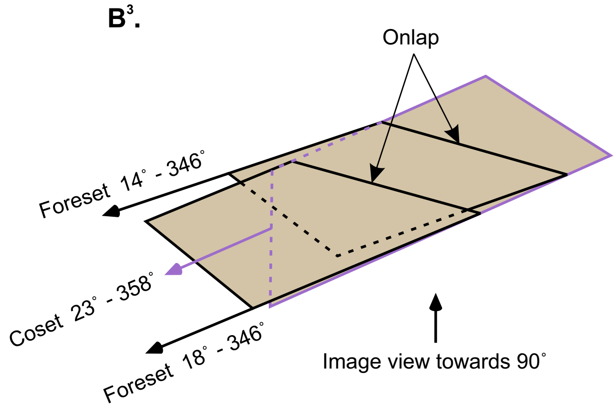


B^{5}.



B^{3}. Tectonically tilted bedding - Facies Sl-hss-of <1.0 m. Foresets appear to possess onlap type relationship with host coset i.e. foreset dip < coset dip. **B^{6}.** Restored field data relating to facies Sl-hss-of <1.0 m; data restored relative to basal facies Stsx <1.5 m now exhibit coset and foreset data consistent with an offlap-downlap relationship and lateral accretion.

B^{3}.



B^{6}.

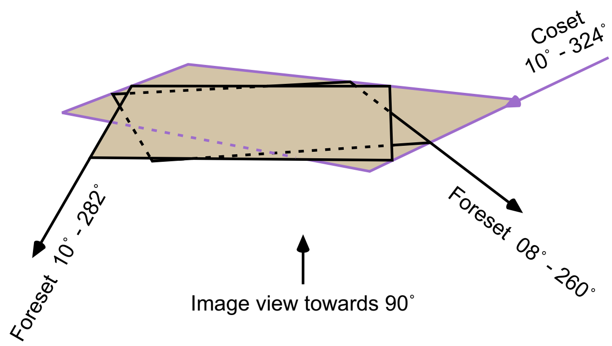


Fig. 4.4B$^{1-3}$. Apparent onlap relationship between coset and component sets and foresets - likely due to tectonic tilting
Fig. 4.4B$^{4-6}$. Offlap relationship between coset and component sets and foresets - apparent 16° tectonic tilt and 016° azimuth restored to horizontal plain

Fig. 4.5 Location 29 - Knox Wood
Metrics Plot and Palaeocurrent Azimuths

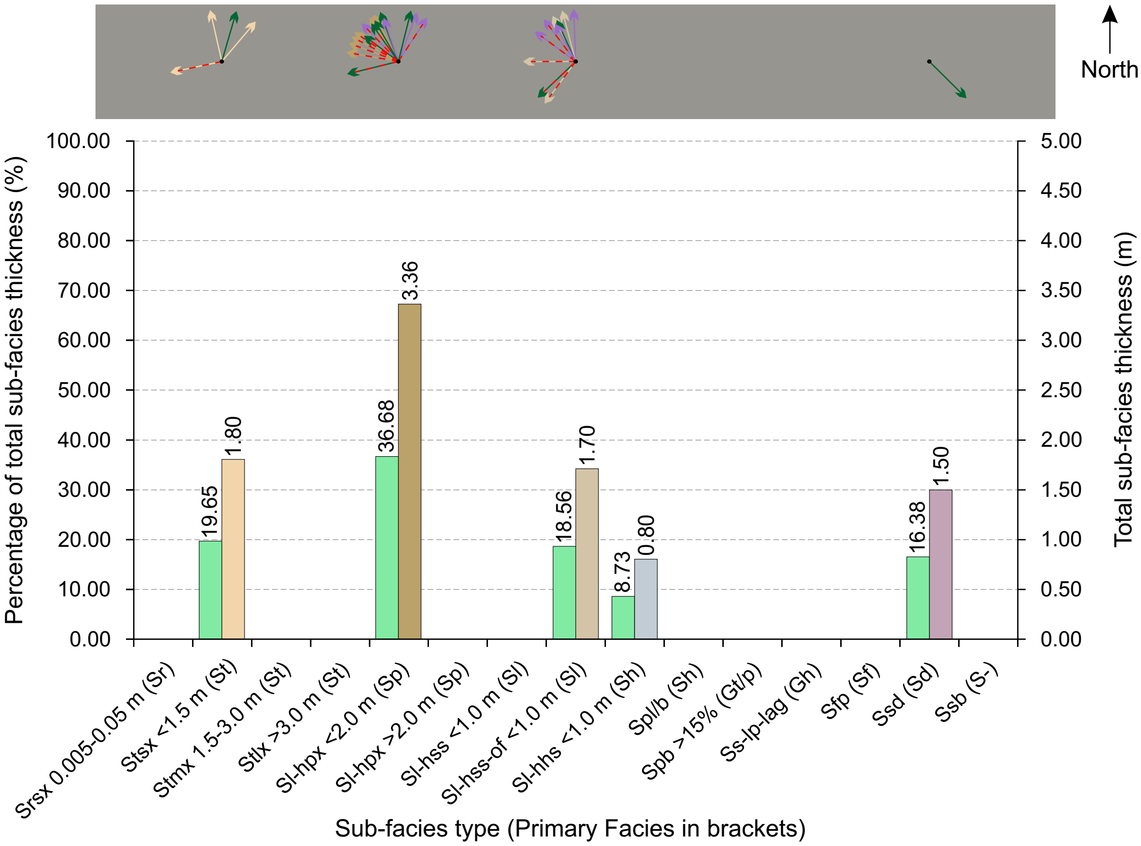


Fig. 4.6 Location 29 - Knox Wood
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

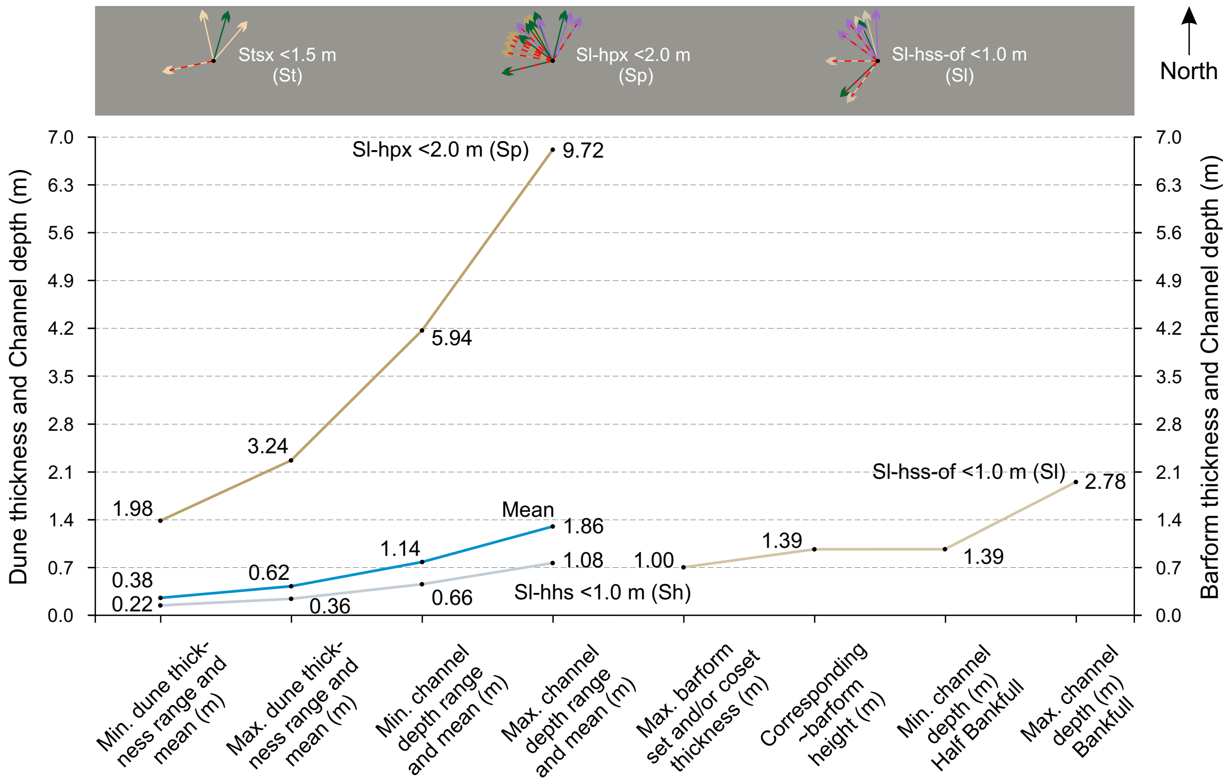
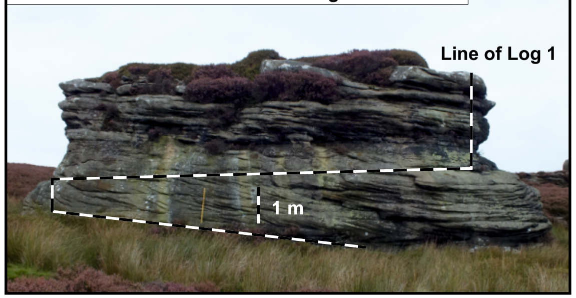
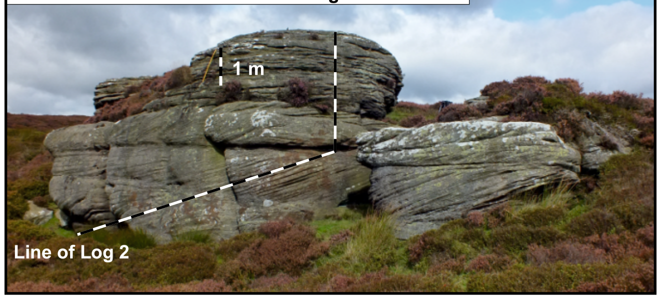


Fig. 4.4 Location 30 - Sigsworth Crags (Outcrops 30.1-30.5) - Grid ref's: SE 14187 70139 - SE 14802 69814 - Elevation: ~350 m - 341 m O.D.

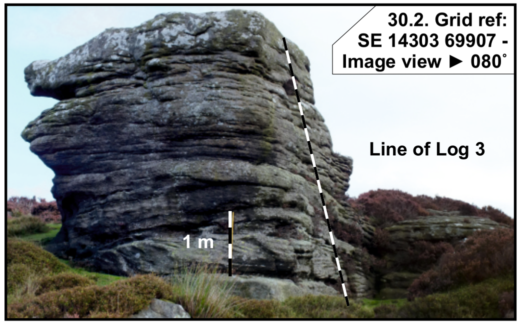
30.5. Grid ref: SE 14802 69814 - Image view ► 024˚



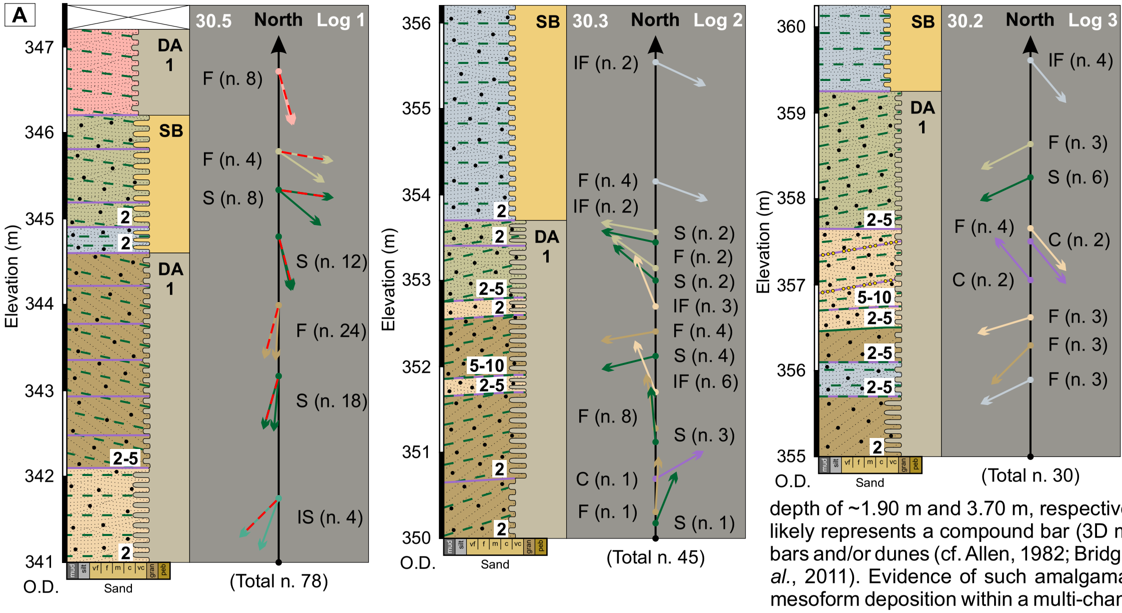
30.3. Grid ref: SE 14512 69808 - Image view ► 350˚

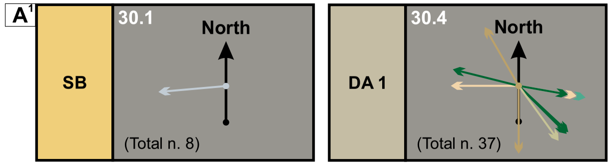


30.2. Grid ref: SE 14303 69907 - Image view ► 080˚



A. Segmented composite sedimentary log section - Sigsworth Crags - Outcrops 30.2, 30.3 and 30.5; **A[1]**. Palaeocurrent data for Outcrops 30.1 and 30.4 - Grid ref's: SE 14187 70139 and SE 14570 69786 (Not illustrated)





Interpretation: (Outcrops 30.2, 30.3 and 30.5) Generally, field data for Outcrops 30.1-30.5 imply that the palaeocurrent was especially variable with deposition influenced by northerly, easterly, southerly and westerly palaeocurrents (Figs 4.4A and A[1]). Variable set thicknesses of between ~0.05 and 0.70 m (facies Sl-hhs <1.0 m and Sl-hpx <2.0 m, Log 1 and Log 3, respectively) imply a maximum dune height and channel depth range of between 0.20-2.50 m and 0.55-7.60 m, respectively (cf. Leclair, 2011). Set/coset thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006); therefore, since individual sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), or bar, and because bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~1.60 m thick coset (facies Sl-hss <1.0 m, Log 3) equates to a maximum bar height and channel depth of ~1.90 m and 3.70 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Outcrop 30.2 likely represents a compound bar (3D macroform) remnant and the amalgamation of several component unit bars and/or dunes (cf. Allen, 1982; Bridge, 2003; Bridge & Lunt, 2006; Sambrook Smith *et al.*, 2006; Ashworth *et al.*, 2011). Evidence of such amalgamation may be reflected in the alternating palaeocurrents attributed to mesoform deposition within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014) and their localised effect on thalweg migration (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). The relatively small-scale mesoforms and shallow channel conditions towards the upper section of the Outcrop 30.2, likely evidence dune-scale stratification decreasing upwards through a bar sequence, thereby reflecting a decrease in flow depth associated with bar stoss and top regions (cf. Best *et al.*, 2003; Bridge & Lunt, 2006) and net sediment deposition during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011). Similarly, preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition (Leeder, 1982), thereby reducing flow depth over the bar top which in turn would increase flow velocity and sediment transport (cf. Reesink & Bridge, 2009). Although the overall interpretation relating to Outcrop 30.3 is similar to that of Outcrop 30.2 above, the initial dominance of facies Sl-hpx <2.0 m may have also facilitated the formation of a sand flat and is consistent with the subsequent deposition of facies similar to Sl-hss <1.0 m and Sl-hhs <1.0 m, for example (cf. Cant & Walker, 1976, 1978). Outcrop 30.5 likely represents the downstream migration of individual mesoforms which probably formed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014) and/or small-scale downstream migrating unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009). Similar to Outcrop 30.3, the dominance of the ~2.50 m thick coset group of facies Sl-hpx <2.0 m may have facilitated the formation of a sand flat (cf. Cant & Walker, 1976, 1978). Further, Outcrops 30.1-30.5 are dominated by a coarse-grained to granular sandstone which coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003). Overall, DA 1 and SB elements likely represent three individual flood migration events (high-flow stage) and associated waning flow net deposition/aggradation of 2D/3D mesoforms (low-flow stage), respectively (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011) and hence channel fill components (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014.

Fig. 4.5 Location 30 - Sigsworth Crags
Metrics Plot and Palaeocurrent Azimuths

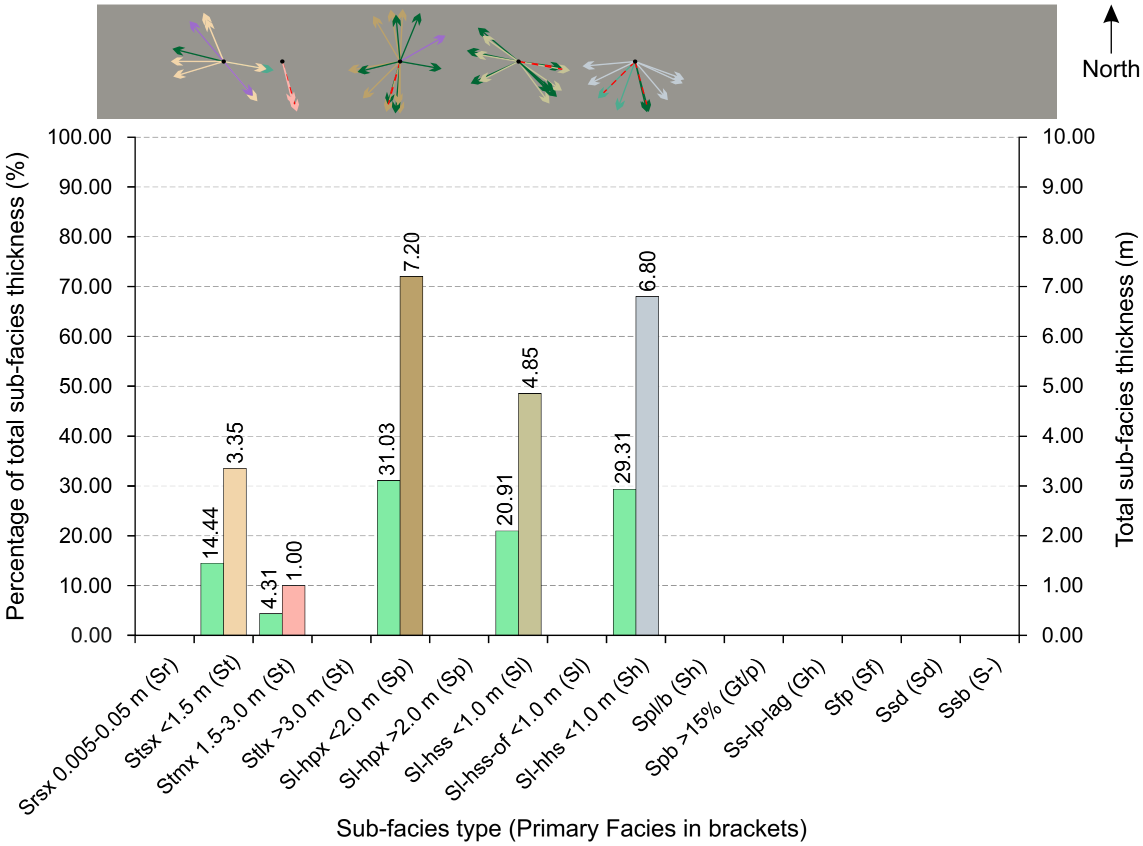


Fig. 4.6 Location 30 - Sigsworth Crags
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

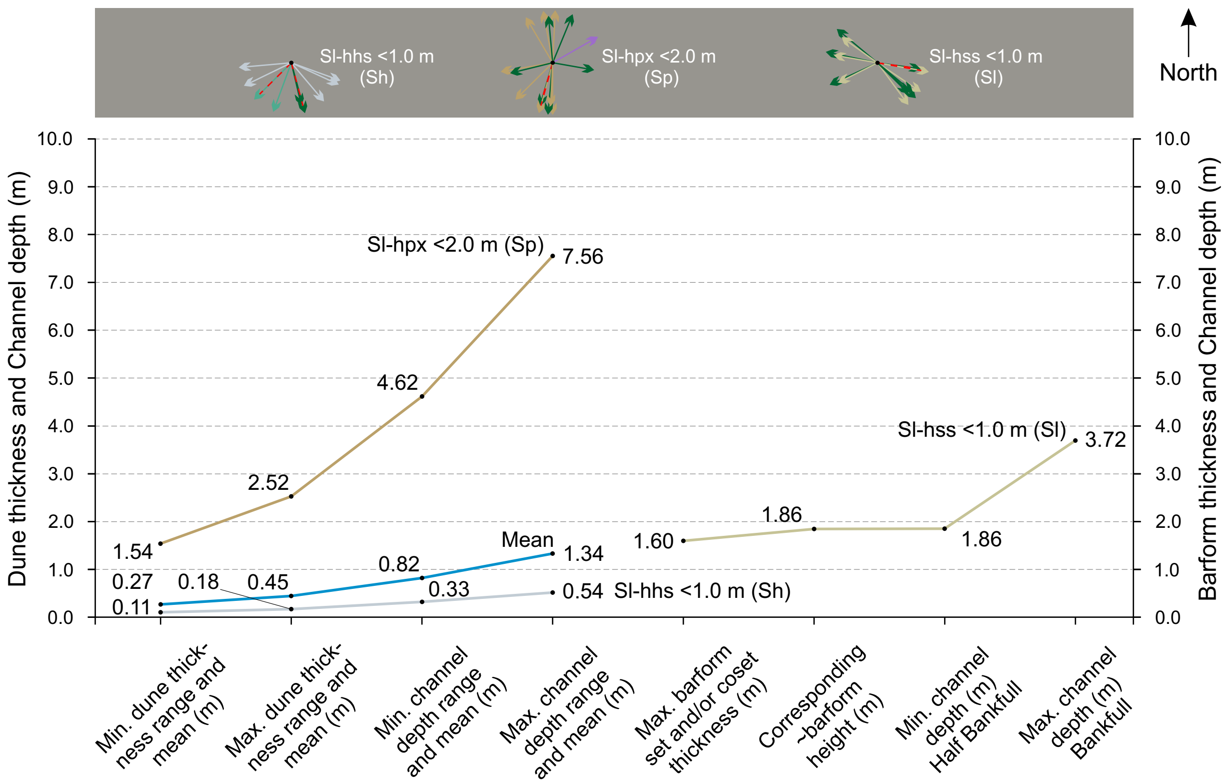
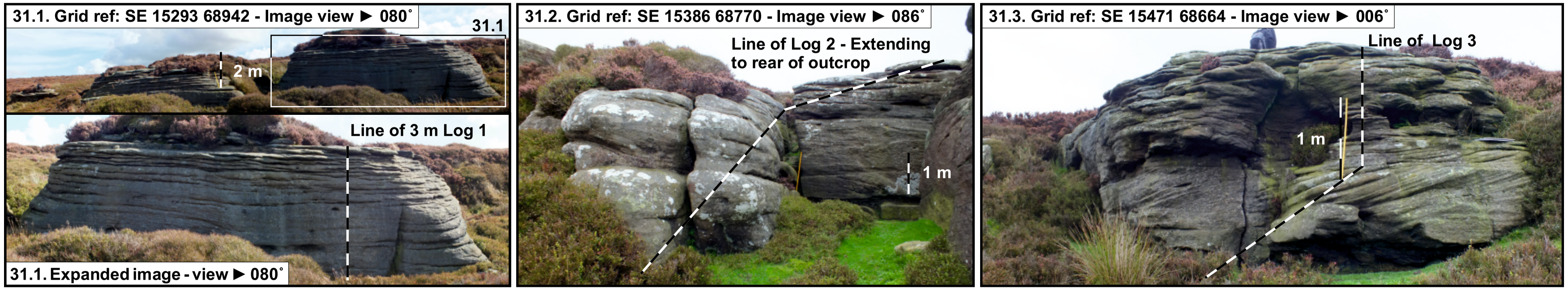
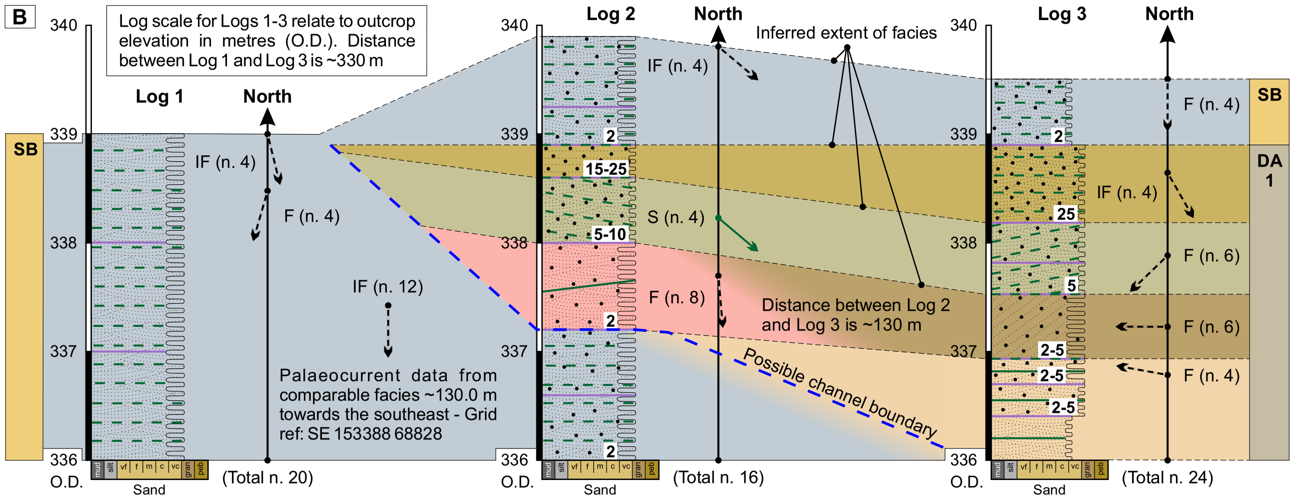
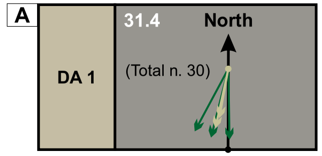


Fig. 4.4 Location 31 - Cow Close Crag (Outcrops 31.1-31.4) - Grid ref's: SE 15293 68942 - SE 15646 68617 - Elevation: 336 m - 332 m O.D.



A. Palaeocurrent data for Outcrop 31.4 - Grid ref: SE 15646 68617 (Not illustrated) and **B**. Fence diagram depicting facies and palaeocurrent associations and possible channel section - Outcrops 31.2- 31.3.





Interpretation: (Outcrops 31.1-31.4) Field data imply a variable palaeocurrent from a southerly and south-easterly direction (Outcrops 31.1-31.2 and upper section of Outcrop 31.3) to a westerly and south-westerly direction (Lower section of Outcrop 31.3 and Outcrop 31.4) (Fig. 4.4A and B). Variable set thicknesses of between ~0.05 and 0.60 m (facies Sl-hss <1.0 m and Sl-hpx <2.0 m, respectively), for example, imply a maximum dune height and channel depth range of between 0.20-2.15 m and 0.55-6.50 m, respectively (cf. Leclair, 2011). Set/coset thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006); therefore, since individual sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), or bar, and because bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al*., 2014), a ~2.00 m thick coset (facies Sl-hss <1.0 m, Outcrop 31.4 - not illustrated) equates to a maximum bar height and channel depth of ~2.40 m and 4.80 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Overall, Outcrops 31.1-31.4 form part of an intermittent line of fragmented outcrops trending northwest - southeast for ~600 m; comparable facies and palaeocurrents throughout the outcrops suggest that they are genetically related. Modern day compound bars may extend several 100's of meters, both downstream and laterally (cf. Bristow, 1993a; Best *et al*., 2003; Bridge & Lunt, 2006) and Cant & Walker (1978) note that sand flats may extend downstream and laterally from 50–2000 m and 30-450 m, respectively, and up to 80% of a channel-belt's width (Sambrook Smith *et al.,* 2006).The dominance of small-scale facies such as Sl-hhs <1.0 m ((Outcrops 31.1 and 3.2) and Sl-hss <1.0 m (Outcrop 31.4 - not illustrated), for example suggest: i. downstream migration and net accretion of 2D or 3D mesoforms within a relatively shallow thalweg region of a low sinuosity channel (cf. Bristow, 1988, 1993a; Ghinassi *et al.,* 2009; Miall, 2010b; Reesink *et al.,* 2014), influenced by waning flow, net sediment aggradation and channel fill (cf. Cant & Walker, 1976; Ashworth *et al*., 2011; Reesink *et al*., 2014); ii. migratory bedforms that likely developed on the surface of a larger sand flat (cf. Cant & Walker, 1976, 1978); or, iii. the latter stages of a channel fill sequence (cf. Reesink *et al*., 2014), since the preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition (Leeder, 1982). Outcrops 31.2 and 31.3 likely represent downstream migration and channel fill sequences with deposition associated with downstream migration of individual small to medium-scale dune components that likely formed within a multi-channelled fluvial system (cf. Reesink *et al*., 2014) and/or downstream migration of unit bars (cf. Sambrook Smith *et al*., 2006; Reesink & Bridge, 2009), probably facilitated by flood events, evidenced by variable channel depths and scour deposits which may delineate channel thalwegs. Relatively low angle first-order set bounding surfaces (≤10°) and sub-horizontal coset contacts (Outcrops 31.1 and 31.4, for example) imply the host channel was relatively broad, which corresponds with McCabe's (1977) observation that distributary channel dips were in the region of ≤10° and Bristow (1987, 1993a) arguing that bounding surfaces, with very low depositional dips, correspond to channels possessing high width to depth ratios. Further, the coarse to granular grain texture relating to Outcrops 31.1-31.4 coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are typical of broad, flat, island-obstructed (bar-obstructed, sensu Bridge, 2003) fluvial systems. Such fluvial systems may influence thalweg migration and alterations in flow direction, likely facilitated by flood events and net sediment deposition (e.g. facies Sl-hpx <2.0 m, Log 3) during falling-flow stage, as indicated by the westerly to southerly adjustment in palaeocurrent (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al*., 2011).

Fig. 4.5 Location 31 - Cow Close Crag
Metrics Plot and Palaeocurrent Azimuths

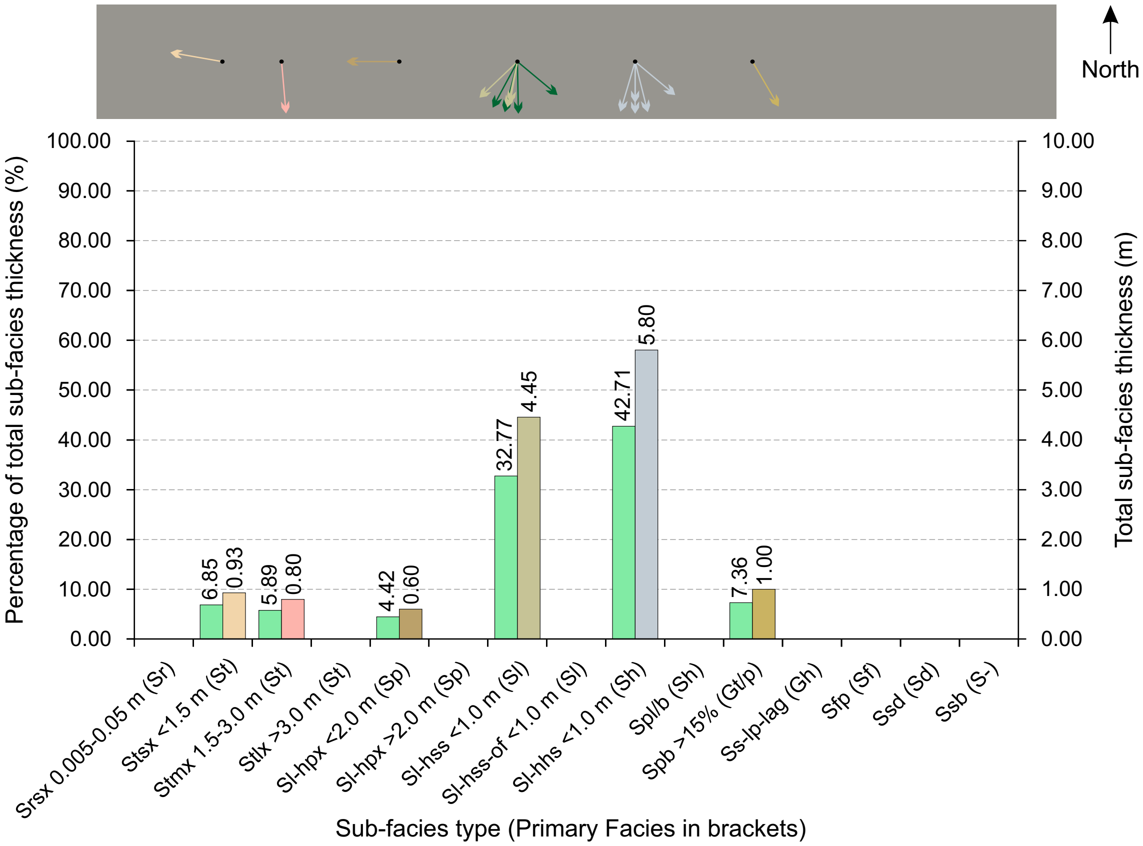


Fig. 4.6 Location 31 - Cow Close Crag
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

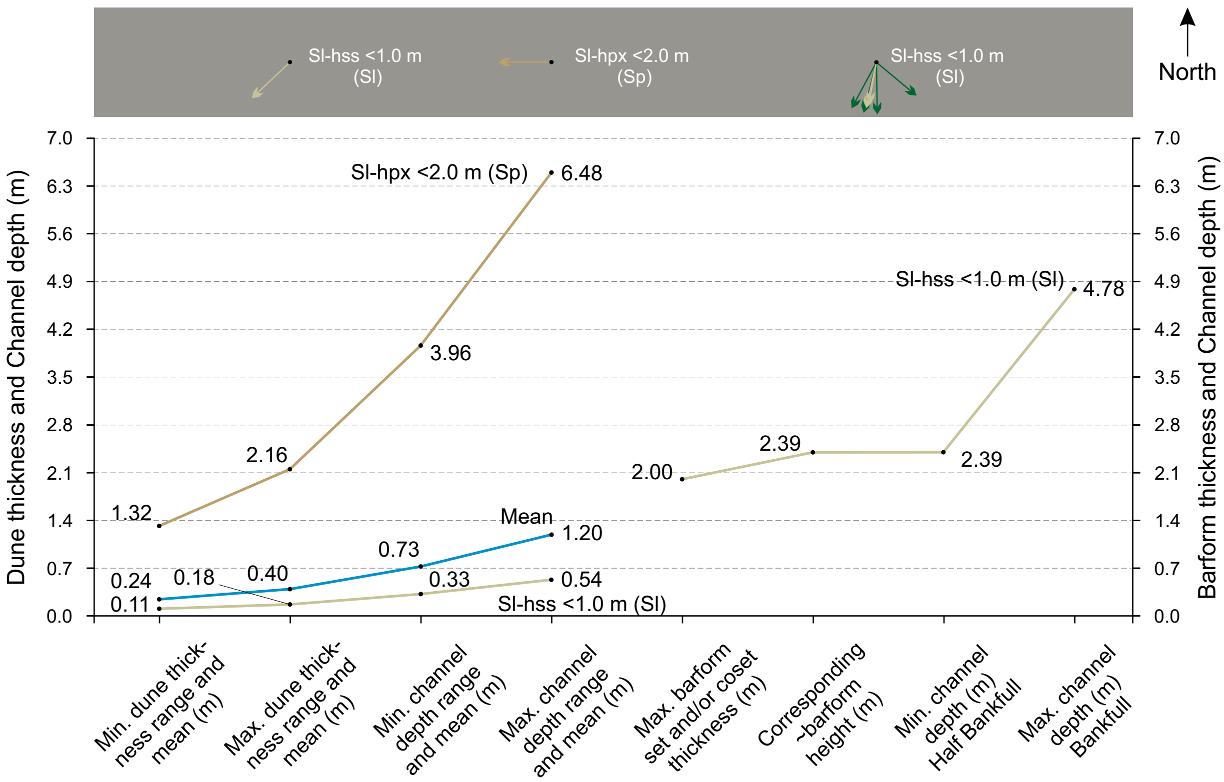
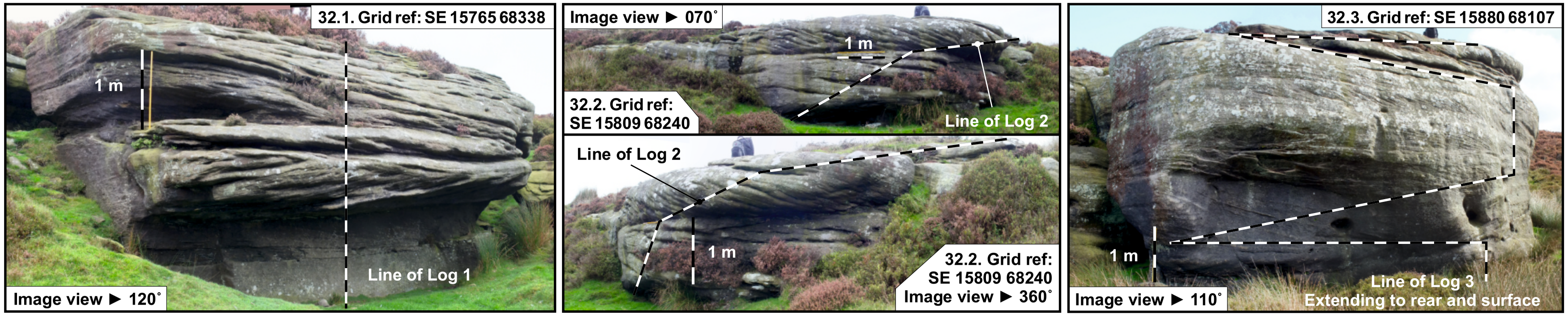


Fig. 4.4 Location 32 - Yeadon Crag (Outcrops 32.1-32.3) - Grid ref's: SE 15765 68338, SE 15809 68240 and SE 15880 68107 - Elevation: ~330, 334 and 340 m O.D.



Interpretation: (Outcrops 32.1-32.3) Field and restored data imply that deposition was influenced by relatively heterogeneous palaeocurrents: Outcrop 32.1 varies from an easterly to northerly trend at the base, an alternating westerly and southerly trend towards the central section and south to south-easterly trend towards the top section (Fig. 4.4A); Outcrop 32.2 varies from a north-easterly trend at the base, a south-westerly trend towards the central section and south-easterly trend towards the top section (Fig. 4.4A); restored palaeocurrent data relating to Outcrop 32.3 imply that deposition was mainly influenced by south-easterly, south-westerly and north-easterly palaeocurrents (Fig. 4.4A). Variable set thicknesses of between ~0.05 and 0.80 m (e.g. facies Sl-hss <1.0 m and Sl-hpx <2.0 m, Outcrop 32.1 and Outcrop 32.3, respectively) imply a maximum dune height and channel depth range of between 0.20-2.90 m and 0.55-8.65 m, respectively (Fig. 4.6) (cf. Leclair, 2011). Set/coset thicknesses ≥1.00 m likely denote unit bars, rather than dunes (Bridge & Lunt, 2006); therefore, since individual sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), or bar, and because bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~2.00 m thick coset (facies Sl-hpx <2.0 m, Outcrop 32.3) equates to a maximum bar height and channel depth of ~3.30 m and ~6.60 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Overall, deposition of Outcrops 32.1-32.3 was probably to some degree mainly associated with the downstream, and lateral migration of: i. individual mesoforms which likely developed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014); ii. unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); and/or iii. individual sets forming dune cosets (cf. Haszeldine, 1983b), or bar cosets (Fig. 4.4A). Further, the cosets relating to facies Stmx <1.5-3.0 m and Sl-hpx <2.0 m (Outcrop 32.3) may have facilitated the formation of a sand flat (cf. Cant & Walker, 1976, 1978). The size of cross-bedding (e.g. 0.70 m, 0.80 m and 0.90 m thick sets and coset relating to facies Sl-hpx <2.0 m, Outcrops 32.1, 32.3 and 32.2, respectively) suggest downstream-accretion within a relatively broad and deep channel with dune migration near to channel thalweg/axis (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Deposition of such bedforms likely produced a localised effect on thalweg migration (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). The observed palaeocurrent variability may also be correlated to the influence of a channel confluence, which are associated with anastomosing channels (McCabe, 1977). Although this study does not examine the morphology or hydrodynamics of confluence zones in any detail, there are numerous studies which examine a variety of channel bar and confluence interactions, for example: i. the formation of alternate bars, McCabe, 1977 and Collinson, 1996; ii. deposition related to confluence scours, Ashmore & Parker, 1983, Miall, 2010b and references there in; iii. morphology and sedimentology, Petts & Thomas (1987); iv. mid-channel bar confluences, Szupiany *et al.*, 2009; v. flow and sediment dynamics, Leite Ribeiro *et al.*, 2012; and vi. hydromorphodynamics, Guillén-Ludeña *et al.*, 2016. The relatively low angle (mainly ≤10°) first and second-order bounding surfaces imply that the host channel was relatively broad. Such an interpretation corresponds with McCabe's (1977) observation that distributary channel dips were in the region of ≤10° and Bristow (1987, 1993a) arguing that bounding surfaces, with very low depositional dips, correspond to channels possessing high width to depth ratios. Equally, Outcrops 32.1-32.3 are dominated by a coarse-grained to granular sandstone texture which coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003). The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition and most sets will climb at a similar angle/dip to that of their host bed (Leeder, 1982); probably influenced by a variable channel depth facilitated by related flood events (high-flow stage) and subsequent net sediment deposition during waning flow (low-flow stage) (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.,* 2011). Such sediment aggradation inevitably encompasses a measure of channel fill and a reduction in overall channel depth (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014).

A. Segmented composite sedimentary log section - Yeadon Crag - Outcrops 32.1-32.3

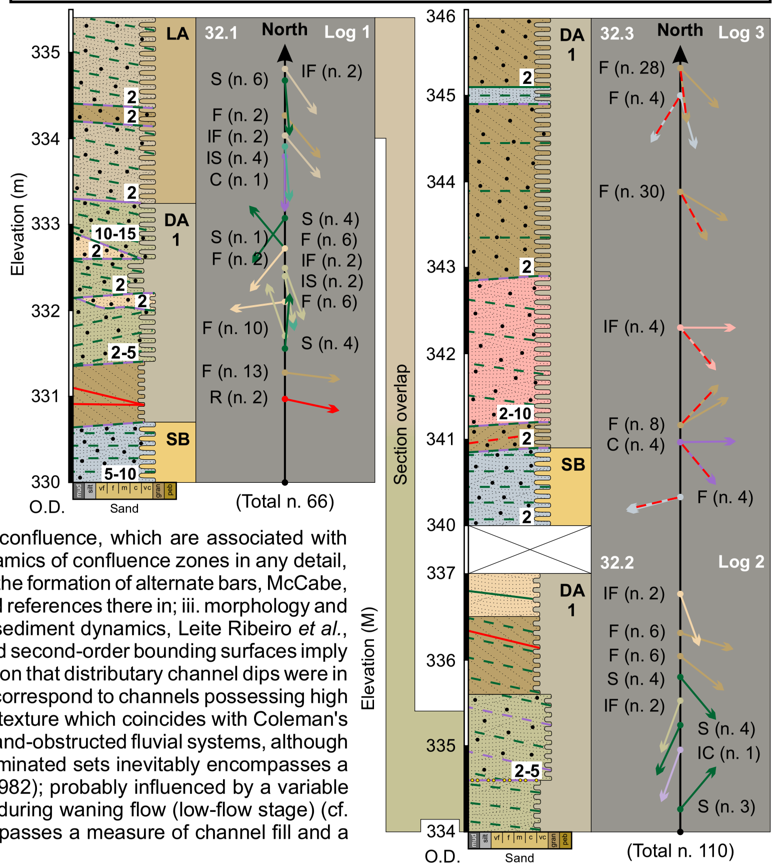


Fig. 4.5 Location 32 - Yeadon Crag
Metrics Plot and Palaeocurrent Azimuths

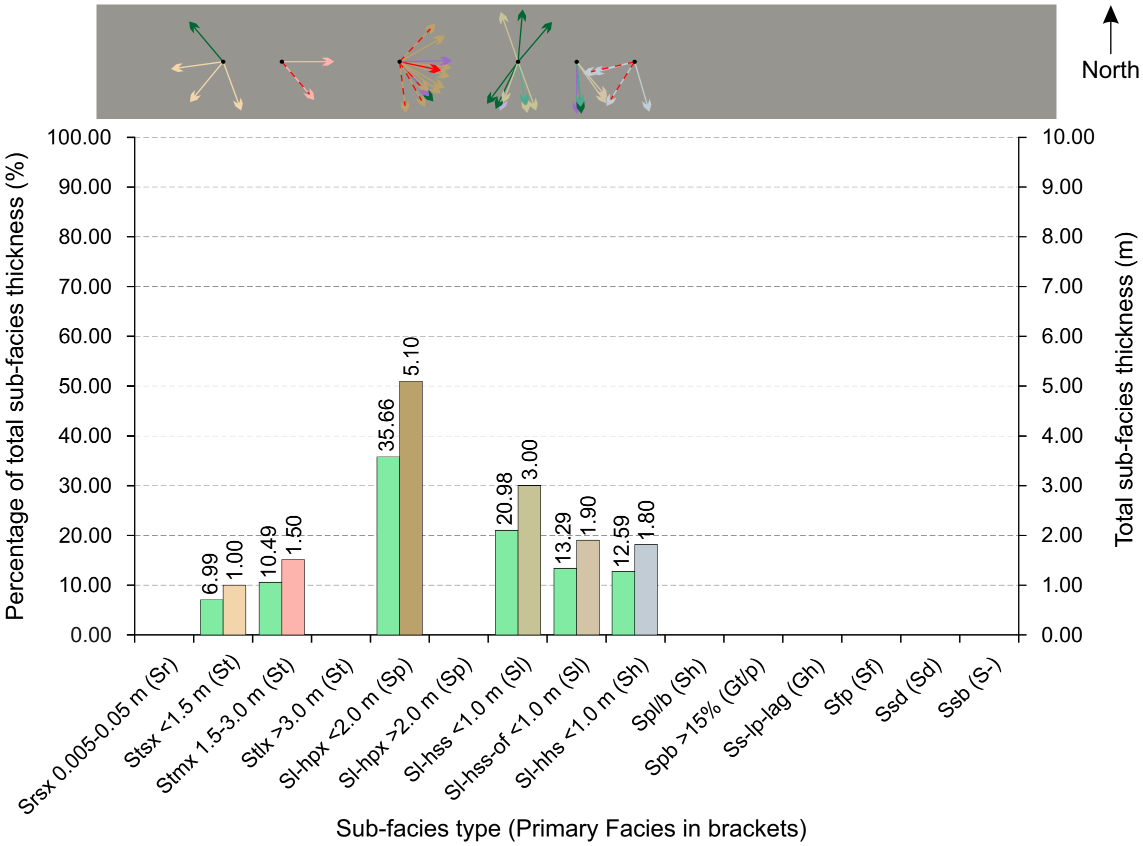


Fig. 4.6 Location 32 - Yeadon Crag
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

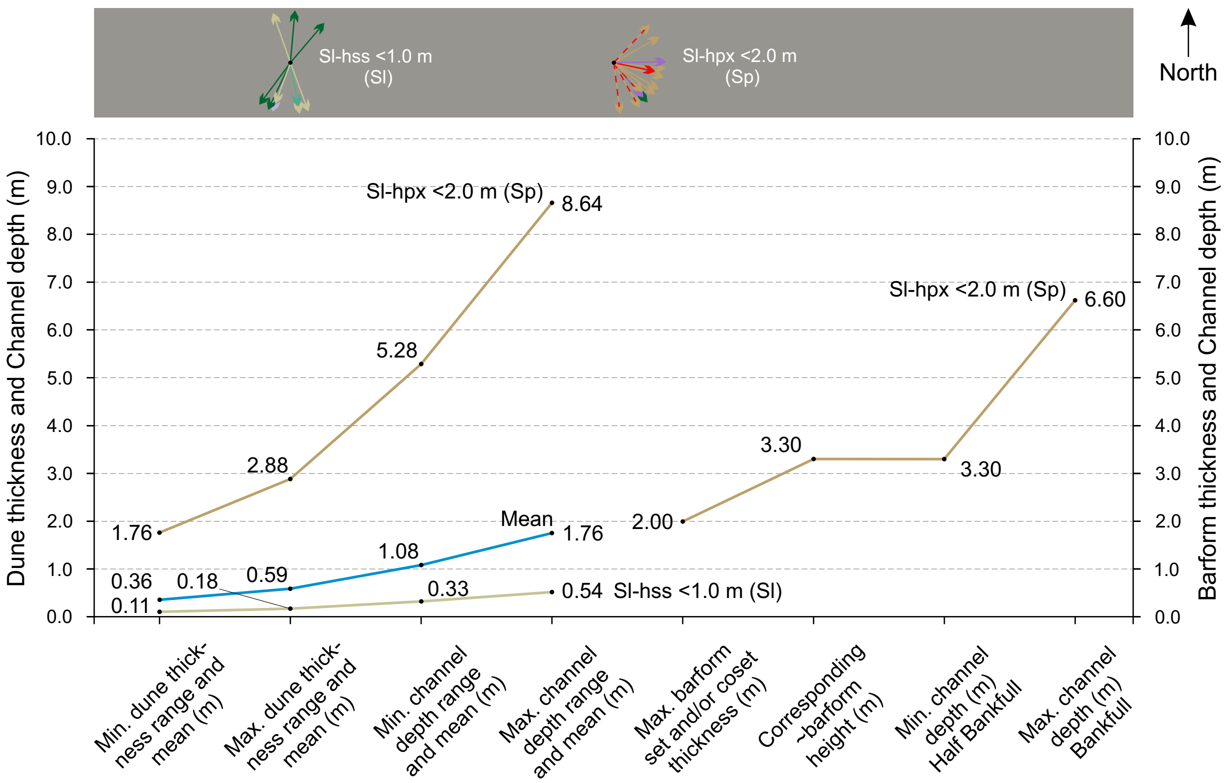
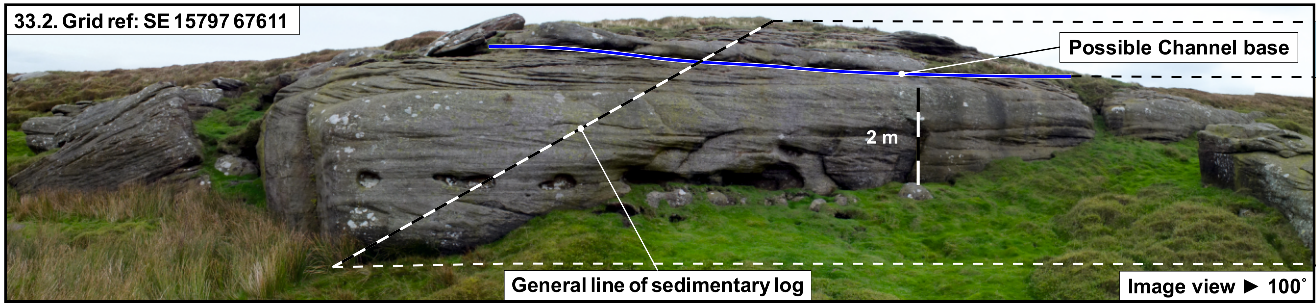
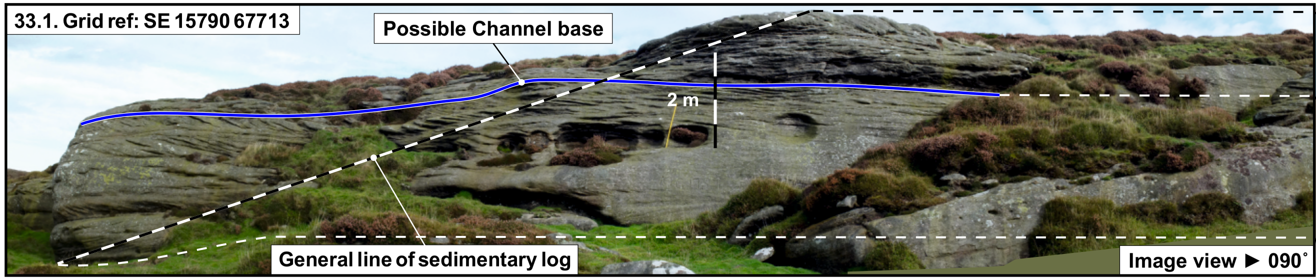
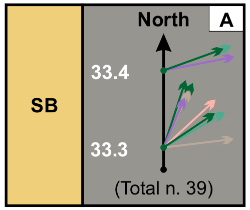
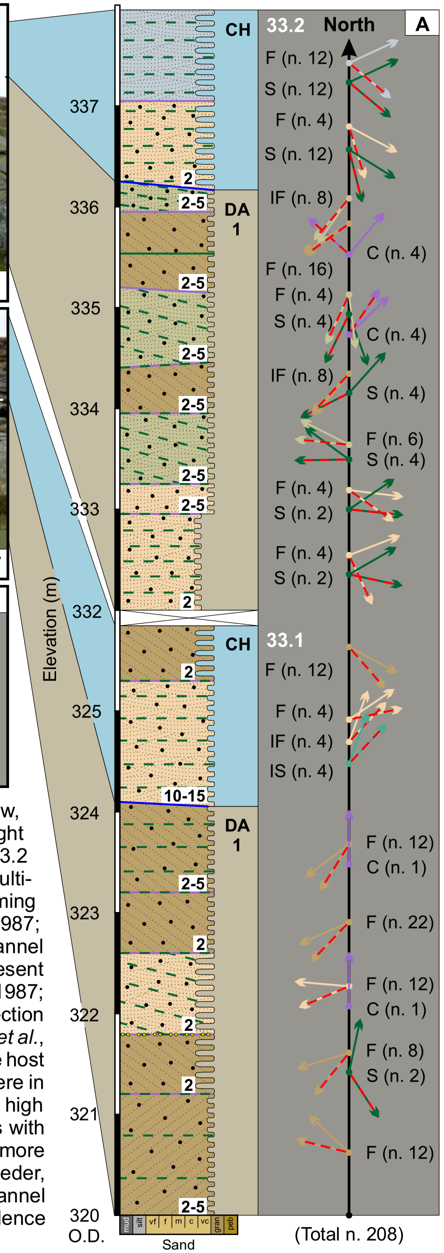


Fig. 4.4 Location 33 - High Bishopside (Outcrops 33.1-33.4) - Grid ref's: SE 15790 67713 - SE 15916 67391 - Elevation: 320 m - 350 m O.D. - A. Sedimentary log and palaeocurrents









Interpretation: (Outcrops 33.1-33.4; facies details and images relating to Outcrops 33.3 and 33.4 - Grid ref's: SE 15846 67483 and SE 15916 67391 - are not included) Field and restored data imply that deposition was influenced by relatively heterogeneous palaeocurrents; restored palaeocurrent data (Outcrops 33.1 and 33.2) varies from a westerly to south-westerly direction (below the channel base) and north-easterly to south-easterly direction (above the channel base) (Fig. 4.4A). Field data relating to Outcrops 33.3 and 33.4 is relatively homogeneous, varying between an easterly and north-easterly direction (Fig. 4.4A), although possible minor cambering towards the north may have produced a 10˚-15˚ easterly bias in the palaeocurrent data. Variable set thicknesses of between ~0.05 and 0.60 m (e.g. facies Sl-hhs <1.0 m and Sl-hpx <2.0 m, Outcrop 33.2 and Outcrop 33.1, respectively) imply a maximum dune height and channel depth range of between 0.20-2.15 m and 0.55-6.50 m, respectively (Fig. 4.6) (cf. Leclair, 2011). Since individual sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), or bar, and because bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~0.80 m thick coset (facies Stsx <1.5 m, Outcrop 33.1) equates to a maximum bar (or cumulative dune) height and channel depth of ~1.20 m and ~2.40 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). Facies related to Outcrops 33.1-33.2 suggest downstream migration and accretion facilitated by in channel deposition of: i. individual mesoforms which likely developed within a multi-channelled fluvial system (cf. Reesink *et al.*, 2014); ii. unit bars (cf. Sambrook Smith *et al.*, 2006; Reesink & Bridge, 2009); and/or iii. individual sets forming dune cosets (cf. Haszeldine, 1983b). Such mesoforms may have also produced a localised effect on thalweg migration (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). Collectively, the mesoforms may have taken the form of a sand flat which in turn hosted the formation of an erosive low angle channel incision into facies Sl-hpx <2.0 m (cf. Miall, 2010b), thereby generating a fifth-order bounding surface (cf. Miall, 2010b). The erosive channel may represent either a constrained first-order channel (through reduced channel flow) or subordinate second or third-order channels (cf. Coleman, 1969; Bristow, 1987; Bridge, 2003; Miall, 2010b and references there in). Equally, a flood event may have initially influenced thalweg migration and alteration in flow direction towards the northeast with the consequential channel scour facilitating deposition of facies Stsx <1.5 m (cf. Coleman, 1969; Bristow, 1987; Ashworth *et al.*, 2011). The relatively horizontal first and second-order bounding surfaces, low angle channel incision and variable size of cross-bedding, imply that the host channel was comparatively broad and deep. Such an interpretation corresponds with McCabe's (1977) observation that distributary channel dips were in the region of ≤10° and Bristow (1987, 1993a) arguing that bounding surfaces, with very low depositional dips, correspond to channels possessing high width to depth ratios. Further, the outcrop's coarse-grained to granular sandstone texture coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003); and the preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition (Leeder, 1982). Generally, Outcrops 33.3 and 33.4 may represent continued east-northeasterly downstream mesoform migration and accretion relating to a channel fill sequence, likely influenced by waning flow and net sediment aggradation (cf. Cant & Walker, 1976; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). Evidence of channel fill is provided by fossilised plant remnants (facies Sfp) which imply the fluvial channel was sufficiently shallow to entrap plant debris.

Fig. 4.5 Location 33 - High Bishopside
Metrics Plot and Palaeocurrent Azimuths

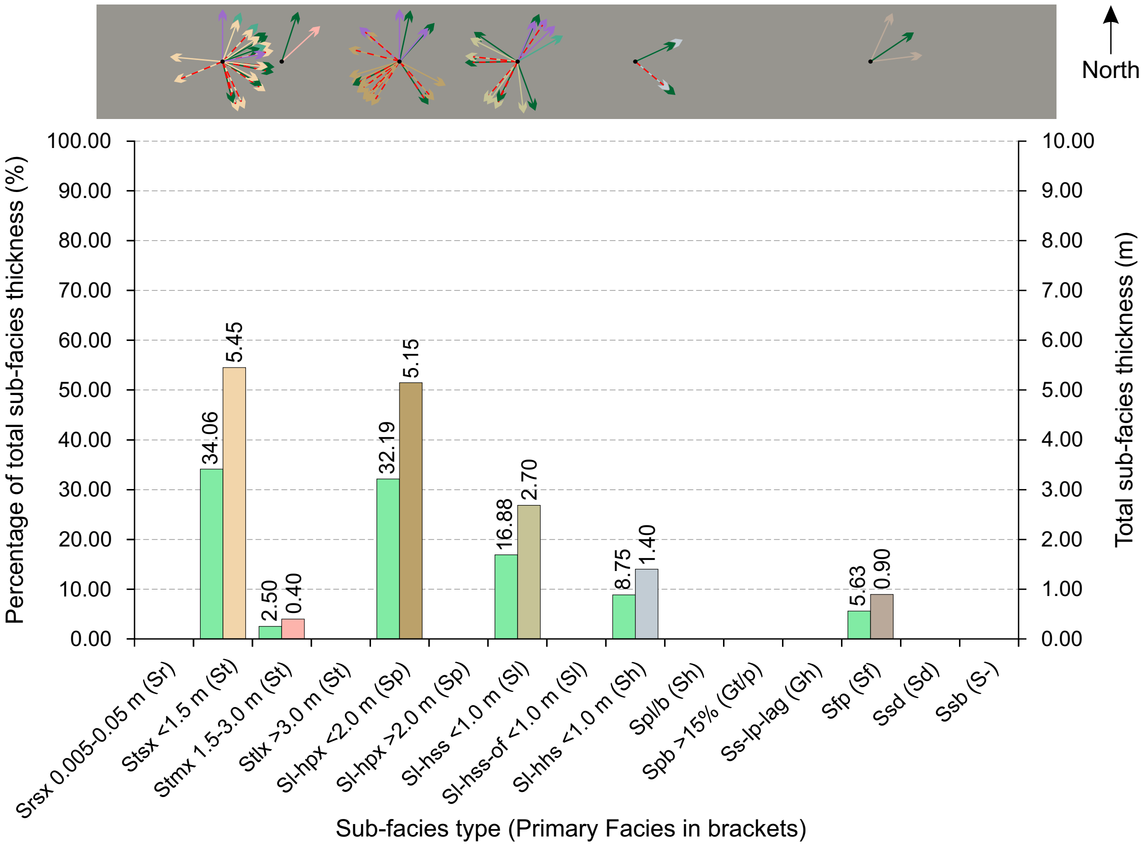


Fig. 4.6 Location 33 - High Bishopside
Dune, Bar and Channel Plot with Palaeocurrent Azimuths

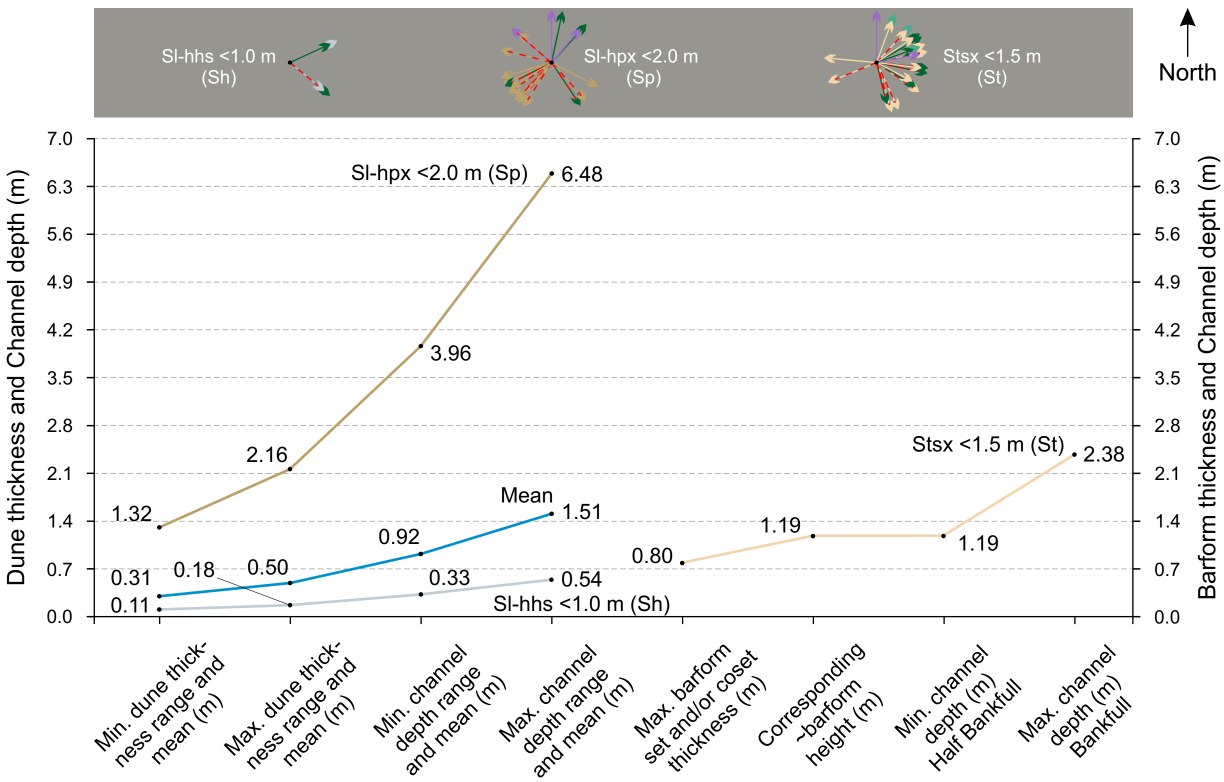
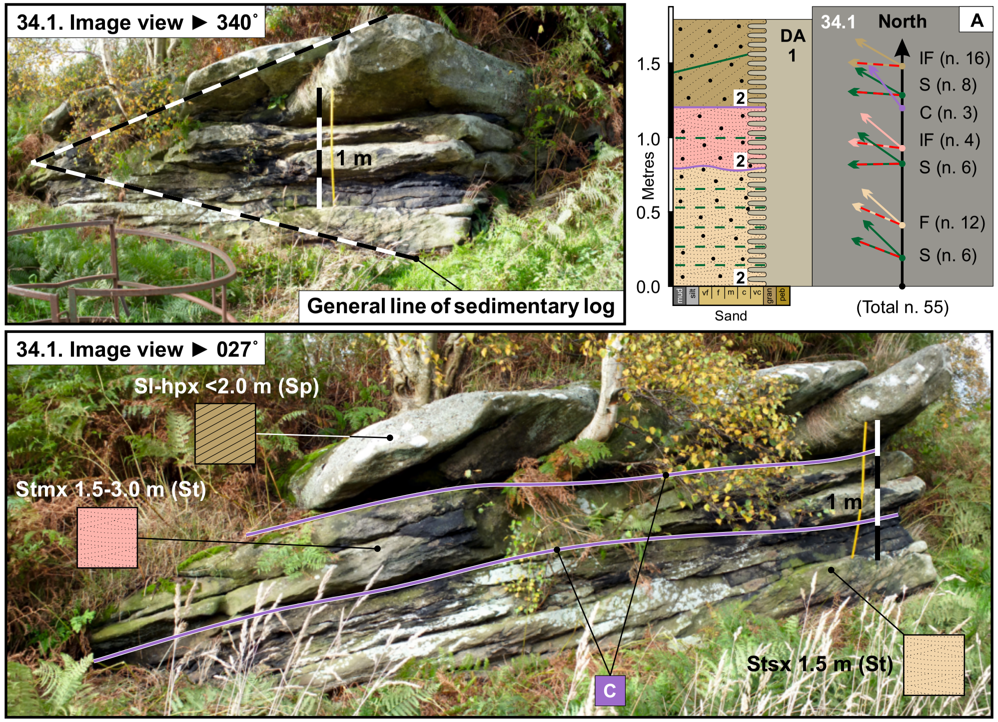


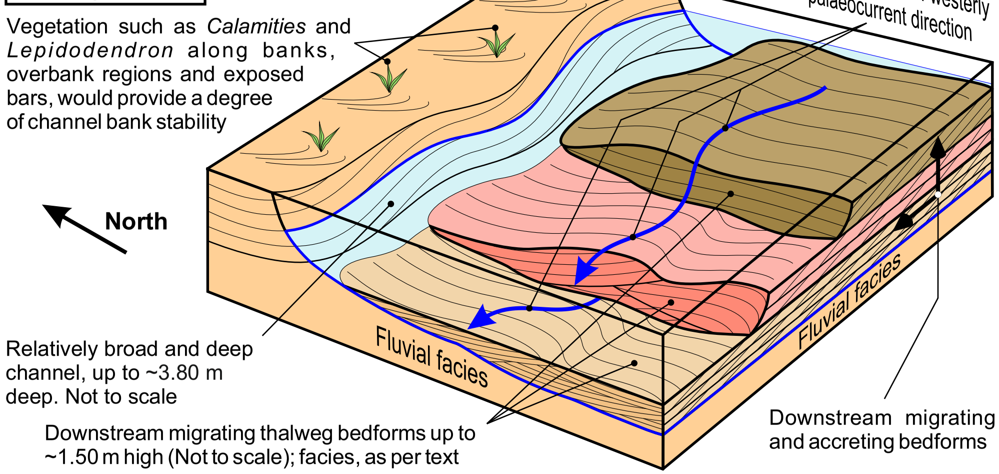
Fig. 4.4 Location 34 - Knoxstone Crags (Outcrop 34.1) - Grid ref: SE 20070 65837 - Elevation: ~206 m O.D. - A. Sedimentary log and palaeocurrents



Interpretation: (Outcrop 34.1) The sub-horizontal bedding relating to Outcrop 34.1 appears to be the result of minor cambering towards the northwest; therefore, palaeocurrent data was restored through stereographic projection relative to the 16˚ dip and 322˚ azimuth inferred from the contact inclinations relating to the boundary between facies Stmx 1.5-3.0 m and Sl-hpx <2.0 m. Although the initial north-westerly palaeocurrent field data appears relatively constant, the restored palaeocurrent data imply that the principal channel flow migrated from a north-westerly direction to a more westerly direction, as the bedform size and channel depth increased (Fig. 4.4A). The restored cross-bedding appears more consistent with that of lateral and/or downstream migrating bedforms; hence, the restored data was adopted when interpreting Outcrop 34.1.

Variable set thicknesses of between ~0.15 and 0.35 m (e.g. facies Stsx <1.5 m and Sl-hpx <2.0 m) imply a maximum dune height and channel depth range of between 0.55-1.25 m and 1.60-3.80 m, respectively (Fig. 4.6) (cf. Leclair, 2011). Since individual sets may form components of a larger host dune coset (cf. Haszeldine, 1983b), or bar, and since bar heights may adjust between half and bankfull depth (cf. Bristow, 1987; Bridge, 2003; Reesink *et al.*, 2014), a ~0.60 m thick coset (facies Sl-hpx <2.0 m) equates to a maximum bar (or cumulative dune) height and channel depth of ~1.50 m and ~3.00 m, respectively (Fig. 4.6) (cf. Reesink & Bridge, 2009; Leclair, 2011). The increasing size of cross-bedding moving up the outcrop sequence implies downstream-accretion within a relatively broad and increasingly deeper channel with dune migration near to the channel thalweg/axis; large dunes tend to develop towards deeper channel thalweg regions within relatively broad/deep channels (cf. Reesink & Bridge, 2009; Ashworth *et al.*, 2011; Reesink *et al.*, 2014). The migration and subsequent net deposition (aggradation) of the 3D and 2D mesoforms was likely facilitated by flood events (high-flow stage) and waning flow (low-flow stage), respectively (cf. Coleman, 1969; Bristow, 1987, 1993a; Ashworth *et al.*, 2011).

B. Schematic representation of downstream-accreting bedforms



Generally, the facies sequence associated with Outcrop 34.1 is probably related to the downstream migration and accretion of channel fill components. The relative increase in set thicknesses moving up the outcrop implies that the channel was progressively deeper moving up the sequence and the restored palaeocurrent data suggests that the principal channel flow migrated from a north-westerly direction to a more westerly direction, as the bedform size and channel depth increased (Fig. 4.4A and B). The preservation of consecutive cross-laminated sets inevitably encompasses a measure of net deposition (Leeder, 1982); thereby reducing flow depth over the component bedform which in turn would increase flow velocity and sediment transport (cf. Reesink & Bridge, 2009). Such conditions would subdue dune formation and generate low relief dunes (cf. Bristow, 1993a), as exhibited by the relatively low-angle bedforms (≤10°) associated with Outcrop 34.1; generally foreset gradients decline as a flow regime intensifies, vice versa (cf. Smith, 1972). Preservation of low-angle bounding surfaces (e.g. facies Stsx <1.5 m and Stmx <1.5-3.0 m) correspond to channels with a high width to depth ratio (Bristow, 1987, 1993a); similarly, the outcrop's coarse-grained to granular sandstone texture coincides with Coleman's (1969) observation that rivers with significant quantities of coarse sediment are representative of broad, flat, island-obstructed fluvial systems, although the term bar-obstructed is more appropriate (sensu Bridge, 2003).

Fig. 4.5 Location 34 - Knoxstone Crags - Fell Beck
Metrics Plot and Palaeocurrent Azimuths

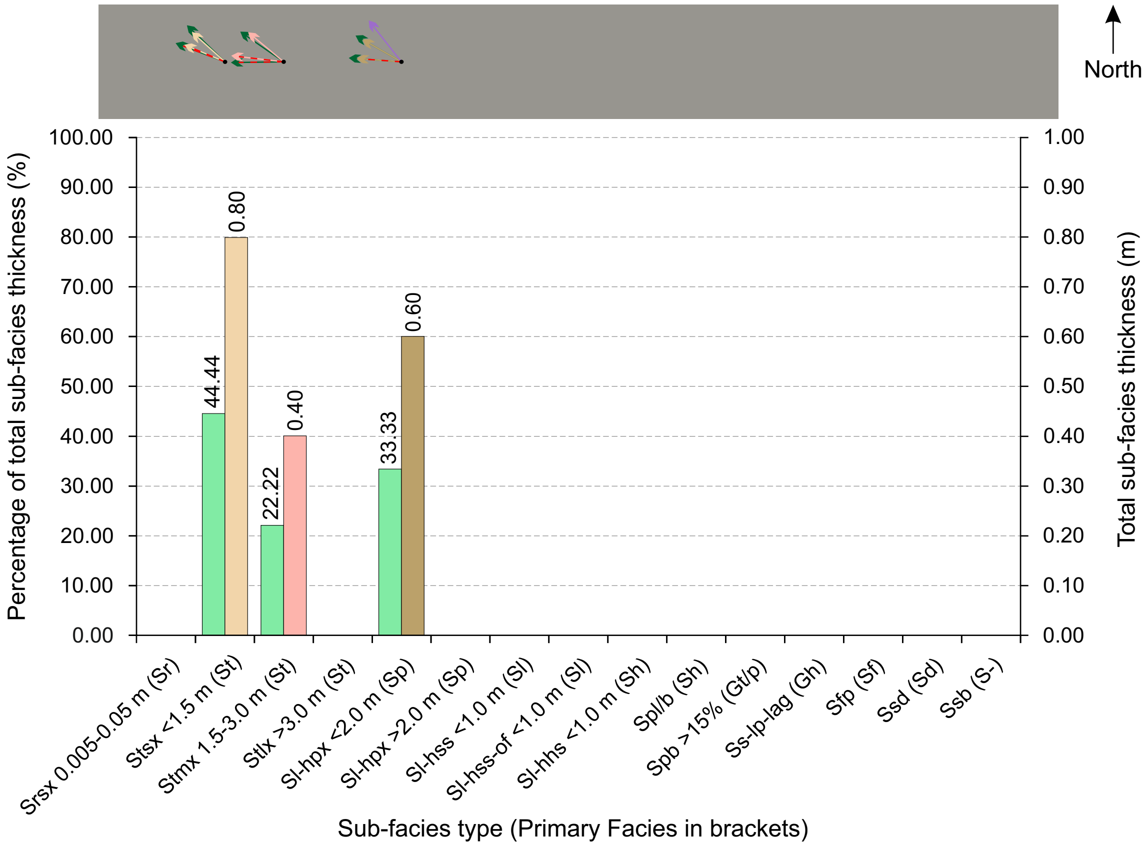


Fig. 4.6 Location 34 - Knoxstone Crags
Dune, Bar and Channel Plot with Palaeocurrent Azimuths