Gold potential of the Roraima Supergroup in Guyana

by

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Mineralium Deposita

Online supplementary material Appendix A30

Description of the new informal formations of the Roraima Supergroup

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Meamu Formation

This basal formation of the Roraima Supergroup has been cored in boreholes 24SW2, 24SW5 and 24SW8 at Mahaica, where it erosively overlies metasedimentary rocks of the Haimaraka Formation. The Meamu Formation ranges in thickness from <1 m in 24SW5 to 69 m in 24SW8 and 79 m in 24SW2. In hole 24SW2, the formation is dominated by lithic conglomerates, whereas in 24SW8, it comprises lithic conglomerates, pebbly sandstone with common lithic pebbles and lacustrine mudrock that are organised into a series of upward-fining cycles. Quartz pebbles are a minor component of the conglomerates, with a maximum pebble size of 70 mm. The dipmeter data from 24SW8 show a well-defined palaeotransport to the southeast, whereas the dipmeter data from the more conglomeratic succession in 24SW2 are scattered with modes to the NW, SE and SSW. At Chi Chi, the Meamu Formation was penetrated in boreholes 33NE9 and 33SE8, where it reaches a thickness of 33 m and comprises a broadly fining-upward succession of lithic conglomerates overlain by pebbly sandstone. Its basal contact with the Haimaraka Formation is sharp and faulted. Dipmeter data suggest a southwesterly palaeotransport direction.

Karanang Formation

At Mahaica, the Lower Member of the Karanang Formation was cored in boreholes 24SW1, 24SW2 and 24SW8 (online supplementary material Appendices A4, A5, A8). It comprises a thick succession of conglomerates capped by pebbly sandstone and/or sandstone with scattered pebbles of as much as 95 mm size, forming a large-scale broadly upward-fining succession, in places >52 m in thickness (in hole 24SW1). In contrast, in hole 24SW8, the member consists of a 2m-thin interval of cross-bedded sandstone with scattered pebbles. In the same area, the Upper Member has been penetrated in boreholes 24SW1, 24SW2, 24SW5 and 24SW8, where it comprises fine- to medium-grained sandstones with red siltstone and mudstone drapes. Its thickness varies from 12 m in 24SW1 to 42 m in 24SW2 and 24SW5, and 81 m in 24SW8.

At Eping, the Lower Member is missing and only the Upper Member was intersected in borehole 33NE1 (online supplementary material Appendix A10), where the upper 26 m were recovered and comprise cross-bedded fine to medium-grained sandstones interbedded with rippled and wavy laminated heterolithic beds of fine-grained sandstone and mudstone. These deposits are interpreted as aeolian dune and damp interdune facies, respectively. An easterly palaeotransport direction is identified from the dipmeter data for this borehole. The Karanang Formation is missing in the ChiChi locality.

Waranau Formation

The Waranau Formation was intersected only by borehole 33NE1 in the Eping locality. There, it is 9 m thick and comprises an overall upward-fining fluvial succession of mostly cross-bedded pebbly sandstone and sandstone with thin conglomerate lags that are capped by muddy heterolithic beds. Maximum quartz pebble diameter is 30 mm. Palaeotransport directions interpreted from the dipmeter log show dominant modes to the SSE and ENE (online supplementary material Appendix A10). The base of the formation marks a sequence boundary between aeolian and fluvial sedimentation. The predominance of sandstone lithofacies suggests a somewhat distal fluvial location.

Kurupung Formation

In the Peaima area, only the Lower Member of this formation was intersected, and it comprises an upward-fining sequence with conglomerate at the base, followed by cross-bedded sandstone with scattered pebbles in the upper part. The member's thickness increases towards the northwest from only 3 m in borehole 24NW1 to 63 m in 23NE2. The maximum quartz pebble diameter in the conglomerate is between 45 and 74 mm. The palaeotransport directions as derived from dipmeter data are inconsistent between the three boreholes sunk in that area (online supplementary material Appendices A2, A3).

In the Mahaica area, three members can be distinguished within the Kurupung Formation. The Lower Member consists of conglomerate, pebbly sandstone and sandstone with scattered pebbles, in variable proportions. It reaches a thickness of between 25 and 94 m. The maximum quartz pebble diameter ranges from 45 to 135 mm. The vertical distribution of lithofacies suggests that this member forms a series of stacked upward-fining channel-fill deposits, which in most boreholes are organised into an overall broadly upward-fining fluvial succession. Within the thicker interval in borehole 24SW5, however, this member can be subdivided into two large-scale broadly upward-fining successions, with a lower conglomerate-prone and an upper sandstone-prone succession, which might reflect the development of two separate fluvial systems. Conglomeratic beds form the base and are up to 23 m thick in borehole 24SW5 but only 7 m in 24SW8. The base of the succession in borehole 24SW2 displays an irregular scoured, possibly pot-holed surface overlain by medium to large pebble conglomerate that suggests lithification of the underlying Karanang Formation prior to erosion. Palaeotransport directions derived from the dipmeter data (online supplementary material Appendices A4, A5, A7, A8) reveal a well-defined SW to SSW mode in boreholes 24SW8, 24SW1 and 24SW2, with NW and SE modes also recognised in hole 24SW2. In contrast, palaeotransport data in the thicker conglomerate-prone succession in hole 24SW5 display a WNW mode that may indicate a different sediment source or entry point to the basin.

The Middle Member of the Kurupung Formation was intersected in all boreholes in the Mahaica area, and it is made up of a fine-grained succession of sandstone, siltstone and mudstone, representing a mix of aeolian, fluvial and lacustrine facies. The Upper Member comprises a thin succession of pebbly sandstone and sandstone with scattered pebbles that has been cored in all boreholes. It ranges in thickness from 6 to 20 m and represents braided fluvial deposits; however, fine-grained aeolian dune sandstone has been recognised in borehole 24SW9 and indicates lateral facies changes and a more distal position at this locality. Maximum quartz pebble diameter ranges from 21 to 48 mm, although pebbles are not observed in the sandstone-dominated succession of hole 24SW8. Palaeotransport data are inconsistent, although some boreholes display WSW to SSW modes.

At Eping, the Lower Member was intersected only in borehole 33NE1 as 12 m-thick upward-fining succession of cross-bedded pebbly sandstone and sandstone with thin conglomerate lags developed on palaeoerosion surfaces. Maximum quartz pebble diameter is 26 mm, and dipmeter logs indicate a strong SSW palaeotransport direction. The gamma ray log shows a distinctly low response over this interval (online supplementary material Appendix A10). In the same area, the Middle Member comprises cross-bedded sandstone containing only scattered pebbles, and is interpreted as distal low-energy fluvial deposit. This member was fully intersected in borehole 33NE1 with a thickness of 16 m and partially intersected in 33NE2 (15m). The Upper Member was fully intersected in boreholes 33NE1 and 33NE2, whereas other boreholes penetrated only the uppermost beds before drilling was stopped. All intersections comprise cross-bedded very fine to fine-grained sandstone interbedded with rippled, wavy laminated and desiccated heterolithic beds of fine-grained sandstone and mudstone.

At Chi Chi, only the Middle Member is developed as an up to 234 m-thick succession that is very similar to that in the Mahaica area.

Mahaica Formation

Three members can be distinguished within the Mahaica Formation, the Lower, Middle and Upper members. At its type locality, Mahaica, this formation comprises interbedded conglomerate, pebbly sandstone and sandstone with scattered pebbles as well as minor mudstone. Its thickness ranges from 27 to 66 m. The vertical distribution of these lithofacies defines a series of upward-fining units which, in the thicker sections, are organised into two large-scale overall upward-fining successions that may represent the deposits of two separate braided fluvial channel systems. Conglomerates are developed at the base of each member and range in thickness in the Lower Member from 32 m (hole 24SW1) to <5 m (hole 33NW1). Those in the upper members are thinner (5 - 9 m) or absent as in hole 24SW3. Maximum quartz pebble diameter varies from 50 to 85 mm. Palaeotransport data derived from the dipmeter, although scattered in some boreholes, point to a dominant sediment source in the north to NNE. In the Peaima area, the appearance of the Mahaica Formation is overall very similar.

At Eping, The Lower Member of the Mahaica Formation was fully intersected by all boreholes and comprises an overall upward-fining succession with predominantly conglomerate in the lower and (pebbly) sandstones in the upper part. The Lower Member shows a distinct thickening trend in a southwesterly direction, reaching a maximum of 38 m in borehole 33NE6. The total thickness of the conglomerates present in this member also shows a southerly thickening trend with only 3.6 m in borehole 33NE3 and 30 m in 33NE5. The maximum quartz pebble diameter is broadly similar throughout the area, varying from 65 to 70 mm. Palaeotransport directions identified from dipmeter logs show a dominant SSW mode in all boreholes apart from 33NE2 where it is towards the southeast (App. A11). The fluvial facies of the Lower Member mark a significant sedimentological change from the aeolian-lake margin setting that prevailed during deposition of the underlying Kurupung Formation. The base of the Lower Member is therefore a major sequence boundary associated with fluvial incision and sediment bypass. The very thick conglomeratic succession of the Lower Member suggests a more proximal fluvial system than encountered at any other stratigraphic level in the Roraima Supergroup in this area. The thickening of the Lower Member in a SW direction suggests that greater accommodation space was available in a basinward direction. Thick conglomerates accumulating in the central part of the Eping locality suggests a possible fluvial gradient change favouring bed-load deposition in that area. The relatively thin conglomeratic interval noted in the northern part of the locality may indicate sediment bypass in this more proximal position.

The Middle Member is very similar to the Lower Member described above. The succession comprises stacked fluvial channel deposits which show an overall upward-fining character passing from conglomerate-dominated channel deposits in the lower part to pebbly sandstone and sandstone-dominated channel deposits in the upper part. The thickness of the Middle Member increases in a southwesterly direction, being absent in borehole 33NE3 and, with 46 m, greatest in 33NE5. The lithofacies distribution follows a similar pattern with conglomerates thinly developed in the north (4 m in 33NE3), most thickly developed in the centre (40 m in 33NE5), and lacking in the south (33NE6). Maximum quartz pebble diameter is greatest in the northern part of the area (70 mm) and least in the southern part (50 mm). A palaeotransport direction to the SSW to SSE is interpreted from the dipmeter logs (online supplementary material Appendices A12, A14). The Middle Member marks rejuvenation of the fluvial system with sediment sourced still from the north. A sequence boundary is placed at the base of the member. Available accommodation space increased basinward, and thick conglomerates of the central parts are possibly related to bedload deposition resulting from a decreased fluvial gradient. Relatively thin conglomerates to the north may indicate sediment bypass due to steep fluvial gradients, whereas an absence of conglomerates in the south may indicate more distal deposits associated with shallow fluvial gradients.

The Upper Member of the Mahaica Formation at Eping consists of cross-bedded conglomerate and pebbly sandstone in the lower part and of cross-bedded sandstone and laminated mudstone in the upper part. In places, distinct clay-draped foresets were identified in the conglomerates and pebbly sandstones (boreholes 33NE2 and 33NE3), indicating deposition under tidal influence. Clay-drapes were not recorded from the other boreholes where all the conglomerates and sandstones have been attributed to fluvial activity. The interval shows a distinctive profile on the gamma ray log due to the presence of mudstone in the upper part, and consequently the interval can be well correlated between the boreholes. The thickness of the interval is greatest in the central (19 m in 33NE5) and northern parts (18 m in 33NE2) but thins towards the southeast (5 m in 33NE3 and 33NE6). Palaeotransport directions identified from the dipmeter logs are bimodal in 33NE1, 33NE5 and 33NE6 showing south to SSE and NNE modes, whereas a SSW-SW mode is indicated for boreholes 33NE2 and 33NE3 and a southeast mode for 33NE4. The maximum quartz pebble diameter recorded in 33NE3 is 67 mm but varies between 45 and 52 mm in the other boreholes.

At Chi Chi, the Mahaica Formation, comprising the same lithofacies as in the other areas, has a sharp and scoured contact with the underlying Kurupung Formation. The thickness of the Mahaica Formation is relatively low in the south of this area (39 m in borehole 33SE8, 35 m in 33SE10) and, with 52 m, thickest in the centre of the area (borehole 33SE2), which also has the greater proportion of conglomeratic lithofacies. Again, a series of small-scale upward-fining units, which are organised into two large-scale broadly upward-fining successions, are interpreted as representing two separate braided fluvial channel systems. Conglomerates dominate in the lowermost of these successions but are relatively thin at the base of the upper one. The maximum quartz pebble diameter (46 – 80 mm) does not show any systematic trend across the area. Palaeotransport directions are dominantly towards southeast in the northern parts of the area and towards southwest and south in the remainder.

Merume Formation

Again, three members can be distinguished within the Merume Formation. At Peaima, the Lower Member has a rather uniform thickness of 31 to 37 m, with variable proportions of conglomerates, pebbly sandstone and sandstone. The vertical distribution of the lithofacies defines two large-scale upward-fining successions. In the lower succession, a basal conglomerate is 9 m thick in borehole 23NE2 but <1 m thick in 23NE1A and absent in 24NW1. Conglomerate at the base of the upper succession is 18 m thick in borehole 23NE2, diminishing to 5 m and 4 m in 23NW1 and 23NE1A, respectively. Maximum quartz pebble diameter is relatively similar in all three boreholes and ranges from 45 to 49 mm. Palaeotransport directions derived from the dipmeter data are consistently to the southwest and west. The Middle Member also has a uniform thickness of 29 to 32 m and comprises fluvial conglomerates, pebbly sandstone and sandstone with scattered pebbles organised in multiple upward-fining channel fill deposits. The conglomerate at the base of the member is 6 to 13 m thick, quartz pebbles therein reach a maximum diameter of 65 mm. Palaeotransport directions are consistently to the southwest. The Upper Member comprises a grossly upward-fining succession of pebbly sandstone and sandstone, locally with a 12 m-thick conglomerate with quartz pebbles of up to 47 mm in diameter in between. Its thickness varies between 15 and 22 m. The palaeotransport directions are to the west in boreholes 23NE1A and 23NE2, and to the southwest in 24NW1.

In the Mahaica area, the Lower Member has a similar thickness as above and shows the same lithofacies. The basal conglomerate is, in places, thicker (up to 22 m) and contains somewhat larger quartz pebbles in the south (up to 64 mm). The palaeotransport directions are variable with modes at WSW to SW and SSE. The Middel Member of the Merume Formation in that area has been truncated by erosion in several boreholes but reaches 54 m in thickness in a complete profile (borehole

33NW1). Nature and extent of the various lithofacies encountered, as well as maximum quartz pebble size and palaeotransport directions are the same as in the Peaima area.

In the Eping area, the Merume Formation was intersected in all six boreholes there. The Lower Member of this formation ranges in thickness from 19 to 43 m. Conglomerates are thickly developed in the northwestern part of this area (holes 33NE1 and 33NE2) but are replaced by pebbly sandstones in the central and northeastern parts (holes 33NE3 and 33NE5) and by sandstones in the south (holes 33NE4 and 33NE6). These lithofacies show a consistent fining towards SSE, which is also reflected by maximum quartz pebble size (up to 65 mm in the northwest decreasing to 35 mm in the south). Palaeotransport directions are mainly to the SSE to SSW in all boreholes (online supplementary material Appendices A10, A11, A12, A14). The Middle Member thins from the north (35 m) to the southeast (19 m). The member is dominated by pebbly sandstone, although locally sandstone (borehole 33NE6) or conglomerate dominates (borehole 33NE3). The maximum quartz pebble diameter ranges from 37 to 78 mm. Similarly, the Upper Member thins from the northeast (21 m) to the south and west (6 m). It is an upward-fining succession of cross-bedded pebbly sandstone and sandstone, with conglomerate occurring at the base in boreholes 33NE5 and 33NE6. The maximum quartz pebble diameter ranges from 41 to 82 mm in the six intersections recovered, although no regional trend in pebble size is evident. Dipmeter data reveal palaeotransport directions to the south and SSW in all boreholes apart from 33NE1 in which an easterly dispersal is indicated (online supplementary material Appendix A10).

In the Chi Chi area, the Lower Member of the Merume Formation displays the same lithofacies as in the other areas. Its thickness decreases towards the north from 39 m to 19 m. The basal conglomerate's thickness decreases from 29 m in borehole 33SE1 to <3 m in borehole 33SE2, and this lithofacies is absent in the north(east). Palaeotransport directions are to the SSW to SSE. The Middle Member is present only in some of the seven boreholes in this area but truncated by erosion in others (33SE1, 33SE2, 33SE8). Its lithofacies and maximum quartz pebble size is very similar to those observed in the other areas. The indicated palaeotransport directions are to the southwest to southeast. The Upper Member has been removed by erosion in boreholes 33SE1, 33SE2, 333SE8; where present, its thickness is 30 to 32 m but decreases to 10 m in the south. Palaeotransport data from most boreholes show a strong south to SSW mode (online supplementary material Appendices A19, A20, A21).

Aruwai Formation

The Aruwai Formation is limited to the Eping area, where it reaches its maximum thickness of 25 m in the northeast (borehole 33NE3) and thins to only 5 m in the south. In most boreholes the formation comprises cross-bedded very fine to fine-grained sandstone interbedded with rippled, wavy laminated and desiccated heterolithic beds of fine-grained sandstone and mudstone. These sedimentary rocks are interpreted as a mixture of aeolian dune, damp sandflat and lacustrine facies that accumulated in a lake margin setting. Cross-bedded sandstone with scattered pebbles dominate the interval in 33NE5 and are interpreted as fluvial deposits representing a river system locally traversing a lake margin. The Aruwai Formation defines a climatically dry episode. The aeolian facies show an easterly to southeasterly palaeotransport direction, whereas the lake margin facies have various modes to the north, south, southwest and east (online supplementary material Appendices A12, A14).

Peaima Formation

In the type area, Peaima, this formation is subdivided into the Lower, Middle and Upper members. The Lower Member consists predominantly of sandstone with scattered pebbles and subordinately of pebbly sandstone and rare thin conglomerate. It is an upward-fining succession of uniform thickness (7 – 8 m). Maximum quartz pebble diameter is between 32 and 48 mm. Palaeotransport directions derived from dipmeter data show a strong SSW mode. The Middle Member is made up of cross-bedded sandstone and mudstone. The Upper Member consists of fluvial pebbly sandstone and sandstone, locally above a potholed surface upon cross-bedded aeolian sandstone and filled by medium-sized pebble conglomerate, in turn overlain by cross-bedded pebbly sandstone. Maximum quartz pebble diameter ranges from 35 to 57 mm. Palaeotransport directions as obtained from dipmeter data indicate a strong southwesterly mode in borehole 24NW1 and a westerly mode in 23NE2 (online supplementary material Appendices A3, A11).

In the Mahaica area, the Peaima Formation is absent in boreholes 24SW8, 24SW5 and 24SW1 (online supplementary material Appendices A4, A7, A8,). Where present, the Peaima Formation erosively overlies sediments of the Middle Member of the Merume Formation, indicating that the Upper Member of the Merume Formation and the Aruwai Formation were removed by erosion, thus forming the sequence boundary at the base of the Peaima Formation. Where encountered, the Lower Member – a series of upward-fining fluvial channel-fill deposits of conglomerate, pebbly sandstone and sandstone with scattered pebbles – is thicker (up to 57 m), with the conglomerate lithofacies at the base of the member reaching as much as 21 m in thickness. Quartz pebbles are as much as 65 mm in diameter. Palaeotransport data suggest a source mainly in the northeast. The Upper Member of the Peaima Formation, where present, comprises an overall upward-fining succession with pebbly sandstone at the base, overlain by a thick interval of sandstone and capped by lacustrine mudrock. The maximum quartz pebble diameter is consistently 45 mm. Dipmeter data suggest palaeotransport directions to the SW to SSW.

In the Eping area, the Lower Member of the Peaima Formation was intersected only in the southern boreholes (33NE4, 33NE5 and 33NE6), where it thickens in a southerly direction to as much as 17 m. There, conglomerates are not developed. Maximum quartz pebble size in pebbly sandstone ranges from 30 to 41 mm. Dipmeter logs indicate southwesterly sediment transport. The Middle Member is absent in this area, whereas the Upper Member is thickly developed (34 – 40 m thick). Again, the member comprises interbedded conglomerate, pebbly sandstone and sandstone in the north, whereas in the south, conglomerates are missing. Maximum quartz pebble diameter decreases southwards from 62 to 38 mm. Dipmeter data indicate sediment dispersal towards the SSW (online supplementary material Appendices A13, A14, A15).

Eping Formation

This formation is absent from the Peiaima and Chi Chi areas, was partly intersected in the Mahaica area and is best developed in the Eping area. Two members are distinguished. In the type area, Eping, the Lower Member comprises cross-bedded pebbly sandstone and sandstone organised into upward-fining channel-fill deposits. No conglomerates were recovered in any of the six boreholes there. A maximum thickness of 40 m is recorded in 33NE2 where the interval consists of two upward-fining successions. The member thins in a southerly direction and is 18 m thick in 33NE6 where only a single upward-fining succession has been recognised. The maximum quartz pebble size is with 60 mm greatest in the northern part of the area and decreases to 25 mm in the south. Palaeotransport directions determined from dipmeter logs are toward the SSE in the northern part and SSW in the southern part of the area (online supplementary material Appendix A11). The Upper Member of the Eping Formation has been partially intersected at the top of all boreholes in the Eping area apart from 33NE3. However, only borehole 33NE6 provides a reasonably thick intersection, whereas the other boreholes sampled only the basal 1-10 m. Conglomerates occur at the base of this member in borehole 33NE2, whereas pebbly sandstone and sandstone were intersected in all other boreholes.

The maximum quartz pebble diameter reaches as much as 70 mm in the north but is with 31 to 35 mm distinctly smaller in the other domains of the Mahaica area. Palaeotransport data from the dipmeter logs indicate former sediment transport to the southeast and south (online supplementary material Appendix A12).

In the Mahaica area, the Lower Member of the Eping Formation was cored in boreholes 24SW3, 24SW9 and 33NW1 (online supplementary material Appendices A6, A9). In hole 24SW3, this member reaches a thickness of 61 m, but its top has been truncated by erosion in holes 24SW9 and 33NW1 where the member's thickness is only 18 and 13 m, respectively. The lithofacies comprise sandstone and pebbly sandstone, with minor conglomerates and mudrock. In hole 24SW3, a large-scale overall upward-fining succession with a thin (<2 m) basal conglomerate is overlain by cross-bedded pebbly sandstone and sandstone with rare interbeds of lacustrine mudstone. The maximum quartz pebble diameter ranges from 25 to 53 mm, with the largest pebbles having been recorded in 24SW3. In hole 24SW9, this member comprises an upward-fining succession with pebbly sandstone at the base overlain by sandstone with scattered pebbles, whereas in hole 33NW1 it is dominated by sandstone. Palaeotransport data are only available from hole 24SW3 and indicate a SSW direction (online supplementary material Appendix A6). The Upper Member was cored in hole 24SW3 where it comprises an approximately 8 m-thick succession of cross-bedded pebbly sandstone, with a maximum quartz pebble diameter of 42 mm. Palaeotransport directions are, as in the Lower Member, to the SSW (online supplementary material Appendix A6).

Parish's Hill Formation

The nine boreholes drilled through the outlier of the Roraima Supergroup at Parish's Hill revealed an overall gentle dip of the strata to the northeast. Borehole PP2 was drilled to a depth of 575 m and provides the longest stratigraphic interval there and corresponds to the informal lithostratigraphic Units I, II, III and IV of {Keats, 1974 #2128} (online supplementary material Appendix A23). Borehole PP3 drilled a 284 m interval equivalent to the lower part of PP2 and was stopped in a dolerite before reaching the base of the Roraima Group. Boreholes PP1, 52SW1, 52SW3, 52SW4, 52SW6 and 52SW7 (online supplementary material Appendices A24, A26, A27, A28, A29) all intersect intervals equivalent to the upper part of PP2 with the objective of targeting potential palaeoplacers.

This upper part of drillcore PP2 is stratigraphically unified as Parish's Hill Formation. It is dominated by cross-bedded sandstone (76-90 %) with minor pebbly sandstones (3-7 %), mudstone (2-5 %) and clast-supported conglomerate (c. 1%). The greater part of the formation comprises fluvial facies interpreted as the distal deposits of a braided fluvial fan system. However, the fluvial succession is interrupted by mudstone and heterolithic beds representing lacustrine and lake margin deposits. These form three distinct stratigraphic marker beds that can be correlated across the locality and provide a framework for stratigraphic subdivision into four members.

The fluvial facies show remarkably similar sedimentary character throughout the Parish's Hill Formation. They are organised into upward-fining facies successions, typically about 4 m in thickness, each interpreted as the deposits of a braided fluvial channel. The base of each succession is characterised by one or more closely spaced (cm-scale) erosion surfaces with associated pebble beds. Commonly the pebbles are sparsely scattered such that only one or two pebbles are seen in the core intersection of each erosion surface. Elsewhere the pebbles are more closely spaced, forming distinct pebbly sandstone or conglomerate beds that are one or two pebbles in thickness and vary between matrix- and clast-supported. They define pebble lags on erosion surfaces and indicate an initial phase of scour and sediment by-pass within the fluvial channel.

The base of each channel succession is overlain by cross-bedded medium to coarse-grained pebbly sandstone. In some cases, pebbles are observed to be locally concentrated along foresets, but most commonly the pebbles are sparsely distributed. Cross-beds range from 0.2 to 1.0 m in thickness and generally show a tabular to broadly trough-shaped form. Fine to medium-grained cross-bedded sandstone forms the upper part of most channel successions, however in some cases, these pass upward into parallel-laminated and cross-laminated very fine to fine-grained sandstones draped by thin clay laminae suggesting the abandonment of the fluvial channel. The foresets of successive cross-beds appear to have broadly similar orientation and imply unimodal sediment dispersal within the fluvial channels. However, in places, major changes in foreset orientation between successive sets were observed and possibly indicate avulsion of braid channels.

The lacustrine facies form intervals up to 1.9 m in thickness and comprise finely interbedded (mm-scale) mudstone, siltstone and to a lesser extent fine-grained sandstone. These beds display fine parallel lamination, symmetrical wave ripples, cross-lamination, starved ripples and desiccation cracks, all of which points at deposition in a standing or sluggishly moving water body that periodically dried up.

The lake margin facies are considerably more heterolithic than the lacustrine facies and comprise mm to cm-scale interbeds of sandstone, siltstone and mudstone, forming intervals of up to 8.8 m in thickness. These beds are dominated by a wavy to irregular laminar fabric (a mixture of synsedimentary and compactional deformation) of parallel laminated, cross-laminated, wave rippled sandstone and mudstone with desiccation cracks, curled mudflakes, rip-up clasts and adhesion ripples. These facies indicate a complex environment involving a mixture of subaqueous processes associated with both flowing and standing water bodies, and aeolian sediment redistribution associated with desiccation, resulting from variations in water table.