Sediment Flux to Ganges-Brahmaputra-Meghna Delta

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The Ganges-Brahmaputra-Meghna (GBM) is one of the youngest fluvio-tidal-deltaic systems in the world. It encompasses with a very dynamic sedimentation process that receives sediment accumulation both from the Himalayas and the natural tidal effect of the Bay of Bengal.Water and sediment discharges are highly skewed to the monsoon resulting 80% of the annual water discharge and 95% of the annual sediment load is come out during the monsoon months of June to September. Bed material, flow condition, geological setting and land use patterns profoundly govern the amount of sediment input and its transport processes. Furthermore, human interventions massively influence the flow pattern and sediment dispersion, which plays an important role in GBM delta formation processes. Several dam construction (planned and executed) and river-linked-project (proposed) at the upper riparian system would influence the flow and sediment input in the GBM systems.
A number of attempts had been taken by many researchers for budgeting the total annual sediment flux of this river systems during the last century. The total sediment flux of the GBM basins is not obvious from literatures as it ranges from 1.06 to 1.67 billion ton of combined mean annual sediment flux stated in several documents. Previous measurements are too old and that also do not represent the present value since a large number of human interventions have been executed in the upper riparian during the last two decades. Also, estimation of the sediment flux vary from river to river because of different measurement methods, time and inter annual river variabilities. Moreover, these measurements were not conducted in the same time series and there was a seasonal effect on the estimation. From literature, it is observed that the Brahmaputra has a mean annual sediment flux of 387 to 650 million tons, on the other hand, the Ganges sediment ranges from 196 to 480 million tons. For the Upper Meghna river systems, the estimation is more dispersed where a maximum mean annual sediment flux of 20 million tons was documented. There is a distinct variation in the mean annual sediment flux of the GBM basin and the reason behind this fluctuation is not clarified yet. Future prediction of sediment flux is very important to assess the sustainability of this delta and accurate quantification of present sediment load is a pre-requisite for this. Any attempt to predict future sediment load in this region needs information about the present-day condition. As a result, it is very important to have reasonable estimate of current sediment flux based on reliable field measurement that will provide the basis of prediction for future sediment fluxes in the GBM system. This kind of prediction is important to support the long-term planning strategies like Bangladesh delta plan 2100 (BDP2100).
Considering all these, a field measurement (4 times a year) programme is planned for the three major river system (at strategic section) of GBM basins—the Ganges, the Brahmaputa and the Upper Meghna, respectively. The measurements will be conducted by using ADCP that considers the Doppler effect of sound waves scattered back from particles within the water column.Sediment concentration obtained from ADCP will be calibrated with the sediment concentration obtained from the water sample collected during the measurement. Moreover, the available sediment concentration data during the last 30 years collected by Bangladesh Water Development Board (BWDB) will be used to determine the trend of the sediment flux. This will be the first of this kind of sediment measurement to compute the sediment flux in the GBM delta and is expected to constitute the basis of all future sediment related research in this region.

Keywords: GBM delta, Sediment Flux, ADCP

Sediment storage and dispersal system of west and southwest Taiwan deltas: millennial to decadal time-scale changes

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The natural setting of Taiwan with high mountains, steep slopes, high gradients of rivers, frequent earthquakes, erodible lithology, and heavy rainfall represents an ideal environment to determine the sediment dispersal from land to the sea over various time scales. Sediment transport from the small mountainous rivers can provide a large amount of sediment into the ocean. These small mountainous rivers of west and southwest Taiwan on the active narrow margin not only transfer terrigenous sediment to the ocean but also have the impact on both the short-term and long-term characters of the coast and seafloor (Syvitski and Saito, 2007; Milliman et al., 2007). Sediment storage, remobilization, and cycles of erosion may be accelerated in this tectonically active region. The west and southwest Taiwan deltas trapping sediments over time scales from millennia to decades showing about 4,700 km^2 of subaerial delta and 2,400 km^2 of the subaqueous delta. To assess the sediment storage in the deltas, the volumes of subaerial and subaqueous deltas were calculated since the last maximum flooding surface in 7 ka to present. Based on the 80 core sites and 112 radiocarbon dates, the volume of sediment deposited over the last 7 ka can be estimated. The volume in the west and southwest Taiwan deltas since 7 ka is 201.1 km^3 and the accumulation rates have been high with averaging about 0.4 cm/yr. Besides, the modern (<100 years) sedimentation rates in average in the Taiwan Strait are ranging about 0.28-0.4 cm/yr (Huh et al., 2011; Hsu et al., 2014). However, the sediment trapping efficiency of the delta region is decreasing at present. The water depth of historical nautical charts allowed the reconstruction of the paleo-bathymetry and paleo-shorelines. The regional deepening and minus volume evaluation indicate the erosional/transport environment and seafloor instability at present. The extreme climate events and human activities in the west and southwest Taiwan may keep delta shrinking in the coming decades.

Keywords: Small mountainous river delta, Accumulation rate, Sediment dispersal system, Taiwan

Delta deposits at the Tsengwen River mouth, western Taiwan

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Taiwan is located in the fold and thrust belts due to the island arc collision action, and the coastal plains along the western coast has been subsiding. Subisidence rate along the western coast is estimated to be approximate 5 mm/yr based on topographical survey and ages of coastal deposits (Ching et al., 2011). Sedimentary facies analysis and measurement of grain size and loss on ignition (LOI) were performed for two borehole core sediment with 250 m long obtained from the Tsengwen River delta, western Taiwan to investigate evolution of the depositonal systems located at tectonically subsiding coasts. Additionally, a new borehole core sediments, 300 m long, was taken near the river mouth in 2015. In the present study, we report the characteristics of the depositonal systems especially the deltaic system on the basis of these cores. The thickness of deltaic deposits showing upward-coarsening succession is about 100 m. Maximum median grain size is 0.3-0.4 mm and LOI is usually less than 6 %. Depositonal age of the deposits may have been during the last 8-9 ka.

Keywords: Sea-level change, Tectonically subsiding lowland, Delta

Estimation of natural and anthropogenic impacts on groundwater resources of Pintung delta plain using numerical spatiotemporal modeling

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This study applies a numerical spatiotemporal dynamic model to estimate the natural and anthropogenic impacts on groundwater resources, and to identify the unstably vulnerable areas which need intensively monitor. The methodology of this study can be divided to six parts: (1) estimate temporal-spatial pattern of pumpage and recharge using coupled analysis of groundwater hydrograph fluctuation and isotope; (2) simulate spatiotemporal groundwater level using numerical model and regard that as actual observed data; (3) compute groundwater storage hydrograph according to observed groundwater level for inverse evaluating the temporal distribution of pumpage and recharge under multiple irrigation practices; (4) apply principle component analysis with observed groundwater level for inverse evaluating the spatial distribution of pumpage and recharge; (5) compute the spatiotemporal distribution of pumpage and recharge and simulate the corresponding groundwater level; and (6) assess the insufficient monitoring areas determined by higher evaluated error of pumpage and recharge. This study applies the established method on the groundwater system of Pintung delta plain. Results show that, the weighted average precise percentage of inverse evaluated temporal-spatial distribution of pumpage and recharge using PCA reaches 95.24%. The spatiotemporal distribution of pumpage and recharge is extremely non-uniform in Pintung plain that annual over-exploitation of shallow groundwater aquifer in tail fan reach 2.89×10^8 m^3. Furthermore, the assessing outcome show that, the area with higher differential value of harmonic mean pattern of leakage rate and with higher groundwater fluctuation amplitude has higher spatial evaluated error. These unstably vulnerable areas are mostly located at the intersection of upstream river and delta boundary and the intersection of downstream river and geological non-homogeneous demarcation.

Keywords: principle component analysis, estimation of pumpage and recharge, numerical groundwater modeling, hydrograph analysis, isotope, vulnerability assessment

Provenance variability associated with East Asian Summer Monsoon precipitation change recorded in the inner shelf deposit of the East China Sea during the middle and late Holocene

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Hydroclimate variations associated with the East Asian Summer Monsoon (EASM) precipitation exert significant impacts on lives of people inhabiting within the Yangtze River drainage and the coastal zone of South China. Seasonal shift of main precipitation area is attributable to the reposition of northern limit of summer monsoon, which would lead to provenance and composition changes of suspended materials transported by the Yangtze River. Consequently, the interannual- to millennial -scale variability in the position of rain belt mentioned above could be recorded in the long-term change in compositional variation of the sediment originated from the suspended materials from the Yangtze River. The inner shelf sediments of the East China Sea (ECS) is of primary importance to study provenance changes of terrestrial materials from the Yangtze River. Because of this expectation, we examined provenance changes in MD06-3040 core sediments recovered from the inner shelf of ECS in association with spatial variability of EASM precipitation.
Provenance of sediment particles were evaluated on the basis of the electron spin resonance (ESR) signal intensity and crystallinity index (CI) of quartz. Comparison the core sediments taken from core MD06-3040 with Yangtze Delta core and modern Yangtze River sediments suggests that the Yangtze River would be a predominant source of the mud belt on the inner shelf of ECS. The ESR value in fine silt fraction of core MD06-3040 samples showed larger values compared to the ESR value in coarse silt fraction during 6.5 to 6 cal kyr BP, 6 to 4 cal kyr BP, and 1.8 to 1 cal kyr BP. The ESR values in both fine silt fraction and coarse silt fraction of core MD06-3040 samples have similar results during 4 to 1.8 cal kyr BP and 1 to 0 cal kyr BP. Moreover, detailed examination of quartz provenance within the Yangtze River drainage using ESR and CI enable us to discriminate the sediment contributions from the upper-middle reaches (northern tributaries) versus lower reach (southern tributaries) of the Yangtze drainage. This observation suggested that variability of the main location of EASM precipitation (EASM front) on multi-centennial to millennial-scale has been detected from this result which showed heavier precipitation in the middle-upper reaches(NW part of the drainage) with contribution from southeastern side of lower reaches (Lakes Dongting and Poyang) and few local rivers during 6 to 4 cal kyr BP, and in the middle-upper reaches(NW part of the drainage) during 4 to 1.8 cal kyr BP, 1.8 to 1.0 cal kyr BP, and 1.0 to 0.6 cal kyr BP.
Modal grain size in fine silt of core MD06-3040 showed notable decrease at times of smaller contribution from EASM precipitation within the Yangtze drainage, such as 6 cal kyr BP, 5.3 cal kyr BP, 4.5 cal kyr BP, 3.7 to 3.3 cal kyr BP, 2.2 cal kyr BP, 1.4 to 1.3 cal kyr BP, which also coincide with the higher value of reconstructed SSS derived from paired measurement of Mg/Ca and $\delta^{18}O$ of foraminifera calcite in core MD06-3040. Such coincidence of low Yangtze discharge events and minima in grain size suggest that the Yangtze River discharge supplied by EASM precipitation should be a dominant control on the Yangtze River discharge, and accordingly influence deposition of Yangtze-derived sediment on the inner shelf of ECS and ECS salinity.High precipitation is correlated with higher contribution of material from the upper and middle reaches of the Yangtze drainage since 6 cal kyr BP.

Keywords: EASM precipitation, Yangtze discharge, East China Sea

Transportation and sedimentary process of fine detrital particles in the Yangtze delta during the late Holocene based on ^{14}C ages of shell fossils, benthic foraminifera, and organic carbon and their paleo-climatological implication

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The Yangtze River is one of the largest river in the world and discharges large amounts of water and sediments into the East China Sea. Such an abundant sediment supply resulted in development of the Yangtze delta during the late Holocene. Initiation and evolution of the Yangtze delta have been discussed using inland and subaqueous sedimentary cores around it.
At present, more than 90 % of the sediments discharged from the Yangtze River are transported in the form of suspended particulate material (SPM). It is generally believed that a part of SPM (= fine detrital particles) shed from the river mouth deposited in the delta and the rest is carried southwestward along the coastline of Southeast China and eventually deposited to form the “Mud Belt”. However, less attention has been paid about how detrital particles discharged from Yangtze were transported and deposited within and around the Yangtze delta.
We drilled the Yangtze delta to reconstruct changes in SPM provenance and examine their relation with climate changes within the Yangtze drainage basin. We conducted ^{14}C dating of shell fossils, benthic foraminifera, and organic carbon to establish the age model. Contrary to our expectation, the result suggests complicated process and/or history of deposition of fine grained detrital particles within the Yangtze delta. We will discuss implications of the result to the sedimentation of fine detrital particles in the Yangtze delta and its possible linkage with the climate change within the Yangtze drainage basin during the late Holocene.

Keywords: Yangtze River, Sediment transportation, 14C dating, Late Holocene, Paleoclimatology

Holocene sea level history in the broad Yangtze River Delta derived from high resolution sediment archives

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The Lower Yangtze River region is one of the key areas of China cradling Neolithic cultures (including early rice domestication), the most representative sites including Kuhuqiao (8-7 ka B.P.) and Hemudu (7-5 ka B.P.) in Ningbo-Shaoxing plain (basin) along the east coast. Over the last few decades, a great deal of work has been carried out to understand how early human settlements coped with Holocene environmental and sea level changes in this critical region. However, reconstruction of sea level history in coastal China has often been hampered by lacking of high resolution records with diagnostic proxies. Existing data retrieved from different regions show great discrepancy and contradiction.
In this study, we chose Ningbo-Shaoxing plain (basin) as the target area for Holocene sea level re-construction. This is because the Ningbo-Shaoxing plain is sheltered to both the north and south by mountain ranges, minimizing the influenced from fluvial and tidal processes, as oppose to the nearby areas such as the Qiantangjiang estuary. This geographic setting would have enabled a relatively continuous and uniform sedimentation during the Holocene, as oppose to the delta and estuary region where sedimentation is often truncated and interrupted by facies changes. As a result, high resolution chronology in Ningbo-Shaoxing plain can be performed and diagnostic paleoenvironmental proxies can be applied.
Eleven core have been recovered from the basin, with lengths ranging from 20m to 40m. High-resolution geochronology of the sediments is established by AMS 14C dating of seeds and plant debris. Dating results suggest that the cores covers age ranges from the Last Glacial Maximum to the present. Sedimentological, biological and geochemical analyses have been carried out to re-construct the environmental history since early Holocene. Of particular interest is the high-resolution sea level history. Combined with archaeological records nearby, the study provides critical information about 1) the timing when marine transgression first arrived in the Ningbo-Shaoxing basin; 2) the timing when sea level reached high stand; 3) the mode of sea level rise; 4) the timing and mode of land initiation, propagation and human occupation. Most importantly, our study sheds some light on the understanding of how Neolithic human beings coped with environmental changes, particularly with sea level changes in this coastal region.

Keywords: Sedimentology

Sea level change and its influence on the Hemudu Culture in the South Yangtze River Delta during the Holocene

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The Neolithic settings of Ningbo-Shaoxing Plain (basin) is famous for the early adoption of cereal cultivation during the Holocene, such as Hemudu Culture. Ningbo-Shaoxing basin is located in the south Yangtze River Delta near the east coast of China. As noticed by many work carried out in this region, the sea level change was one of the most important challenge for the early settlements during the early to middle Holocene. However, there still lacks a unified understanding about the sea level change history.

As Ningbo-Shaoxing basin is sheltered by the north mountain ranges from direct erosion of tidal process, we retrieved a series relative continuous sediment cores with uniform lithology, to understand the land and sea interaction in this basin. In this study, one core located away from, but close to the Tianluoshan site (a representative site of Hemudu Culture) was chose, as a natural sedimentation. Among many different proxies, diatom is a well-known biological indicator of fresh and marine environment. Nevertheless, in previous studies, there is rare systematic study about diatom at this area. Besides, X-Ray Fluorescence (XRF) scanning can provide different geochemical elements curves in the sediment in a high-resolution and semi-quantitative way.

In this study, diatom, XRF scanning and grain size analyses was carried out, based on a high resolution AMS ^{14}C chronology frame. This study assesses the timing when sea transgression reached this area and when sea retreated, also the pattern of sea level change during the early to middle Holocene. The result shows that during the period of sea level rise, there were several short-term periods influenced by fresh water input, which was indicated by predominately fresh diatom species than marine species. Moreover, Calcium content from XRF scanning has a significant correlation with the relative abundance of marine diatom species, which may provide a high resolution sea level history. These results may make important contribution to the understanding of how early settlements adapt to sea level change in this area.

Keywords: sea level , diatom, XRF

Three dimensional morphological changes and ^{137}Cs dating in the Yellow River (Huanghe) delta during 1976-2012

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The Yellow River (Huanghe) is a major sediment supplier to the Bohai Sea and the Yellow Sea. Since 1976 the river's channel has been located on the east side of delta complex and has built out broad sedimentary lobe. To understand the sedimentation of the subaqueous delta, extensive bathymetric and high resolution seismic profiles, vibrocores and a borehole core in the survey lines were collected in 2012. The morphological change along with ^{137}Cs profiles of cores were used to establish the present sedimentary frame of delta front slope and to examine sediment dispersal in the west of Laizhou Bay in this study. Sedimentation and morphological change in the area were examined on the basis of (1) the morphological change between 1958/1976 and 2012 and (2) analyses of sediment cores including radionuclides (^{137}Cs and ^{210}Pb), sediment structure and texture. The morphological change shows the distribution of sedimentation since 1976, and this also was validated on basis of analysis of cores. About 80% Yellow River-derived sediment deposits in the subaqueous delta during 1976-2012. The morphological change also reveal the present morphology of subaqueous delta that exceeds previous estimated boundary, and this also was validate on basis of analysis of ^{137}Cs in cores. The ^{137}Cs onset depths corresponding to the depths of lithological changes and morphological changes indicate that it can be a proxy to track the dispersal of Yellow River-derived sediments in the study area. Synthesis of bathymetry, seismic profiles, ^{137}Cs profiles and surface sediment pattern show that a depocenter occurs in the south frank of Yellow River delta in the west of Laizhou Bay. The deposition probably results from the headland eddy that formed with the morphological change.

Keywords: Morphological change , Sediment cores, Cs-137

Fluvial to tidal transition in the Mekong River delta, Vietnam

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The Mekong River delta extends from its apex at Phnom Penh in Cambodia to the Vietnamese coast, and from the Saigon River mouth in the east to Cape Camau in the west. The delta plain area exceeds 50,000 km^2. The delta has prograded more than 200 km during the last 6–7 ka. The middle Holocene sea-level highstand is recognized at ~2 m above present sea level in this region. The delta owes its great size to the combination of a huge sediment supply and a stable sea level for the last 6–7 ka. The area around the mouth of the Mekong is meso-tidal with a maximum tidal range of 3.2–3.8 m. Tidal effects are obvious in the water level as far as ~100 to 150 km upstream from the river mouth throughout the year, but particularly in dry seasons. The zero meter level of the river channel thalweg is ~600 km upstream, in Cambodia. Freshwater and sediment discharges from upstream occur mostly in the wet season from May to November; however, ocean tides exert strong influences in the dry season, including re-suspension of sediment in river channels.
To better quantify the influence of river discharge and tides on river-bottom sediments, we collected >250 surface samples from distributary channels across the entire delta in Vietnam from the border to the five river mouths during the dry season (January–May 2015), and from one distributary channel from the border to the river mouth during the wet season (October 2015) with simultaneous CTD measurements. In the dry season, river- and tide-dominated areas can be spatially distinguished by the sedimentary facies (grain size and sedimentary structures) of channel bottom sediments. Tidal rhythmites (sand-mud couplets) are common as far as ~100 km upstream from the river mouths, and mud balls are often found in the middle reaches of distributaries. The spatial distribution of river- and tide-dominated areas is closely linked to channel morphology. The thalwegs of river channels show deepening trends, with large variations, downstream from the border and suddenly change to shallowing trends near their mouths. Coarse sediments are found mostly in regions with a deepening trend and sand-mud couplets are found in regions with a shallowing trend. During the wet season, most of the rivers are occupied by freshwater, and the 0.5 pss salinity line is only ~5 km upstream from the river mouth. Nevertheless, sand-mud couplets are recognized up to ~100 km upstream from the river mouth in this freshwater environment.

Keywords: Mekong River, fluvial-tidal transition, estuary

Holocene tidal changes around the Mekong River Delta, Vietnam

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Numerical simulation was conducted to reconstruct tidal changes taken place within and around the Mekong River Delta during the Holocene. The paleobathymetry used in this study was based on GIA model and was modified by removing thick Holocene deposits existent in major deltas facing the South China Sea, e.g., Mekong, Red, Chao Phraya, and Pearl river deltas. A preliminary result shows that semi-diurnal tidal currents were developed at the inner portion of the paleo Mekong estuary during the mid-Holocene transgressive stage, suggesting stronger influence of tides on the delta formation than at present.

Keywords: delta, South China Sea, paleotidal modeling, Holocene transgression

Holocene intra-estuarine deltas of south-western Australia –testing and extending delta classification

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An *intra-estuarine delta* is a delta that occurs wholly within an estuary. The prefix 'intra' emphasises that these deltas are sedimentary accumulations *within* the estuary. They are relatively small in comparison to open-coastal deltas. South Western Australia provides excellent examples of relatively large estuaries with numerous inflowing rivers and a large number of intra-estuarine deltas which can be used for testing and exploring the classifications of deltas.
In the estuaries of south-western Australia, with asymmetric distribution of wave climates, and/or differential shelter from wind and wind-waves, intra-estuarine deltas do not readily conform to the idealised pattern of delta development and cannot be readily classified using traditional delta classification. For instance, they may show geomorphic asymmetry in response to their orientation to wave climates and wind, so that they may be wholly wave-dominated, or partly wave-dominated in one part, and fluvially dominated in another part of the delta system. In an estuary with symmetrical delta-land development a symmetrical stratigraphy usually develops but with asymmetry in evolutionary development the deltaic stratigraphy may be laterally asymmetrical.
To deal with such variations and to highlight them, we have developed a classification approach for intra-estuarine deltas, an approach that we believe also can be applied to open-coastal deltas. The classification involves identifying the delta attributes and systematically applying descriptors for these attributes in terms of delta size (megascale, macroscale, mesoscale), plan-form (lobate, cuspate, digitate, birds-foot, palmate, elongate, crenulate, rectangular, fretted, symmetrical, asymmetrical), internal landforms, , delta origin or genetics (*viz.*, wave-dominated, tide-dominated, fluvially-dominated, and whether the delta is monogenetic, *e.g.*, wholly wave-dominated, or poly genetic, *e.g.*, part wave-dominated and part fluvially-dominated), and homogeneity/heterogeneity of the stratigraphy. A full classification of an intra-estuarine delta is achieved by including all the attributes described above as adjectival descriptors. In south-western Australia, for instance, the Deep River intra-estuarine delta is a mesoscale, monogenetic wave-dominated, internally geomorphically asymmetric and stratigraphically asymmetric. The Preston River intra-estuarine delta, another example, is macroscale, polygenetic tide- and fluvially-dominated, internally geomorphically asymmetric, and stratigraphically asymmetric. The Harvey River intra-estuarine delta is macroscale, monogenetic fluvially-dominated, internally geomorphically and stratigraphically symmetric. As such, an intra-estuarine delta system, or even an open-coastal delta system can be classified systematically to separate and expand the diversity of delta types worldwide.

Keywords: deltas, intra-estuarine deltas, classification, south-western Australia, estuaries

Determining the geoheritage significance of deltas using the Geoheritage Tool-kit

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Geoheritage is the heritage value assigned to features of a geological nature, encompassing Globally, Nationally, State-wide to Regionally, and locally significant features of Earth Science. Sites of geoheritage significance are intrinsically important or culturally important, offering information or insights into the evolution of the Earth, or into the history of Earth Science, or that can be used for research, teaching, or reference. Features of geoheritage significance can range from the small scale such as crystals to the large scale such as mountain ranges and drainage basins. While there has been a focus on geological features of geoheritage significance in the record of rocks, palaeontology, minerals, and landscapes, there has been little emphasis placed on the geoheritage significance of deltas.
In terms of geodiversity and geoheritage values, deltas provide a rich assortment of geologic, geomorphic, sedimentologic, mineralogic, and biogenic attributes, not only in regards to the features within the deltas themselves, but also in the geology, geomorphology, and hydrology of the immediately surrounding landscape that borders them or (if in an estuary) that frames them. Deltas provide a wealth of features of geoheritage significance: from the large scale expressed as delta types and stratigraphic sequences to the small scale of sedimentary products and diagenesis. Consequently, they lend themselves to qualifying as sites of geoheritage significance. This is especially the case in that deltas derive from and reside in various types of geologic, geomorphic settings, and oceanographic settings which results in a wide variety of delta types; they occur in a wide range of climates from tropical to temperate, and from humid to arid, which also results in a wide expression of delta types stratigraphically, sedimentologically, and geochemically/mineralogically.
The Geoheritage Tool-kit has been developed to systematically catalogue and evaluate different aspects of geology, assign them as to category of geoheritage site, rank them as to size, and then evaluate individual features or package of features as to their significance. The Geoheritage Tool-kit can be systematically applied to deltas to help identify Internationally and Nationally significant deltas as a basis for management and geoconservation. Applying the Geoheritage Tool-kit to deltas worldwide and to specific case examples in Australia shows a range of environmentally significant deltas.

Keywords: delta, geoheritage, Geoheritage Tool-kit, geodiversity

