Prospecting for clay in the jungles of Borneo: the Belaga Formation, Nanga Sumpa, Batang Ai, Sarawak

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Abstract: This article is a light-hearted account of a geological experience in the jungles of Sarawak, highlighting some of the difficulties encountered during one of my expeditions. The area under investigation was near the Nanga Sumpa Longhouse, located on the Batang Ai River, situated in the Lupar Valley, southwest Sarawak, East Malaysia, on the Island of Borneo. The Layer Member, part of the Belaga Formation, is of Upper Cretaceous age (65–95 million years old) and is composed mainly of metamorphic muds and sands. The sedimentary origins of these slates/phyllites and metagreywackes have been interpreted as distal turbidites. The clay in question was deposited through suspension fall-out during the final stages of turbidite flows. The mission was to locate sites, yielding clay suitable for potting in order to replace the already diminishing supplies, used up by the local Iban people.

INTRODUCTION

This article documents a Geological trip into the Batang Ai region of Sarawak. The aim of the trip was to help local potters in the area search for potting clay in order to enlarge their ever-depleting resource. The clay was used to make household utensils and artefacts for tourists by Iban Potters who live in the Nanga Sumpa Long House. This account hopes to give an outline of the Geology of the region and an insight into the shortfalls of prospecting in such a difficult terrain.

LOCALITY

Batang Ai River is located in the Lupar Valley, southwest Sarawak, East Malaysia, on the Island of Borneo (Fig. 1). In the lower reaches of the river below the town of Lubok Antu, the Batang Ai is known as the Batang Lupar. The Batang Ai area is vegetated by dense primary and secondary jungle, covering hilly topography, which is dissected by numerous rivers and shallow streams in the lower and upper reaches of the drainage basin. The topographic features strongly reflect the underlying geology of the area with the Marup Ridge forming the most prominent feature in the area. This ridge extends in an almost straight line from near Simanggang southeastward to Bukit Besai (Denis, 1979). The Batang Lupar and its four major tributaries, the Batang Lemanak, Batang Undup, Sungai Kumpang and Sungai Entulang, drain most of the valley area.

POPULATION

The area is populated predominantly by the Iban people, one of the indigenous native populations of Borneo. The Ibans live close to the river and inhabit what is known as a longhouse. These longhouses are rattan/bamboo structures built on stilts, joining many household units together, which share a communal gallery (Figs. 2 and 3). The Ibans are predominantly hillrice farmers who use shifting cultivation methods for subsistence use. Other produce includes some cash crops such as pepper and rubber for local sale. One of the alternative sources of income for these Longhouse's are the adventure-seeking tourists, who mainly come from Europe, USA, Canada and Australia, with smaller numbers from Japan and Singapore (Zeppel, 1995). During these tourist visits, handicrafts produced by the longhouse inhabitants are sold to the visiting guests. The artefacts range from tapestries and carvings to jewellery and ceramics.

In one of these longhouse's, a place named Nanga Sumpa, situated up the Batang Ai River

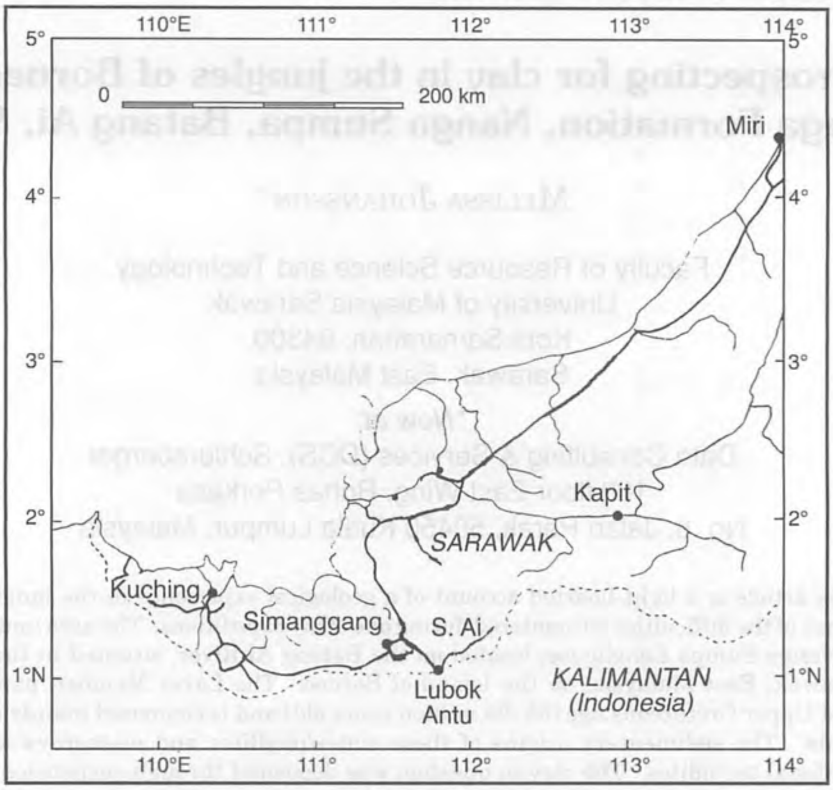

Figure 1. Location map.

Figure 2. The longhouse at Nanga Sumpa.

Figure 3. The bridge over the river at Nanga Sumpa.

Figure 4. Steeply deeping beds of the Layar Member at a waterfall.

System, an intensive study of the production of ceramic pots was undertaken by UNIMAS (pers. com. Sabina Teuteburg, 1996). During this study, it was discovered that the source clay utilised for the production of pottery in the longhouse was diminishing. The source having been excavated by potters for a couple of generations. Therefore an expedition to Nanga Sumpa was organised to locate more potting clay in the vicinity of the longhouse, so that their tradition of potting could continue.

CLAY — A DEFINITION

On exposure of the rocks at the earth's surface, the rocks begin to weather owing to the inherent instability of the minerals when exposed to a low pressure/temperature atmosphere and the combined corrosive and erosive effects of oxidation and hydration. These minerals therefore breakdown to form what is known as 'clay'. The term 'clay' usually means a fine-grained material which when mixed with water becomes extremely plastic and mouldable (Hall, 1987). However, in the restricted sense the term, 'clay' describes a chemically heterogeneous and structurally complex assemblage of colloidal particles, having a mean diameter ranging from a few microns (μm) down to a few hundredths of a micron (a micron is a thousandth of a millimetre). The mudstones at Nanga Sumpa comprise predominantly quartz, white micas, albite, chlorite with accessory minerals including zircon, hematite, tourmaline, apatite and opaque minerals (Denis, 1979). This clay forms one of the most important constituents of soil in terms of soil structure and nutrition, but also forms an important resource for man, for example brick making, fillers and ceramics. In ceramics it is important that the clay contains no coarse grained particles which could hinder the kilning process.

GEOLOGICAL HISTORY

The Nanga Sumpa Longhouse is located on rocks known as the Layer Member, which forms the oldest member of the Belaga Formation. The Layer Member underlies an area about 254 km^2 in size and is estimated to be around 40 km in width (Liechti *et al.*, 1960). The Layer Member is of Upper Cretaceous age (65–95 million years old) and is composed mainly of metamorphic muds and sands, known as slates/phyllites and metagreywackes, respectively. These sedimentary rocks are interpreted as distal turbidites. Distal turbidites are deep marine sediments, which have been deposited from the final stages of a density current (also known as a turbidity current).

Deep marine turbidity currents generally originate from the continental shelf due to a sudden input of sediment. This sediment influx is normally generated by a catastrophic event such as an earthquake. The sediment mass travels far in to the ocean basin driven by both gravity and density variables. The density variable originates from the contrast between a dense sediment rich flow and the surrounding seawater. The grains are supported by a turbulent ambient fluid which reduces the frictional drag of any grain to grain interaction and allows the sediment to be transported kilometres into the ocean basin. As the sediment-laden turbidity current flows down the continental slope from the continental shelf to ocean basin, sediment is deposited. The sediment forms a succession of grain sizes from coarse to fine material, from a proximal to distal locality. Therefore the heavier materials, such as cobbles and gravels, are initially deposited because of their greater size, with the sandy materials following suit. The silts and muds deposit later when quieter waters allow the clay to settle out of suspension.

Therefore at Nanga Sumpa the muddy deposits represent the fall out from the final remnants of a turbidity current existing 65–95 million years ago. The sandy lenses reflect incursions of higher energy events into the same basinal or geographical area. The afore-mentioned sedimentary processes are not indicative of a marine environment, as these deposits can occur in any hydraulic system where sediment influxes occur. However, the marine environment is interpreted from fossil evidence, which indicate saline tolerant species (Denis, 1979). Therefore the prevailing environment is thought to be a quiescent deep marine environment.

Since deposition, the Layer Member has undergone burial and metamorphism. The Layer Member exhibits intense, tight overturned folding with beds generally dipping steeply towards the north and northeast at angles between 60° and 85° (Fig. 4). The inclined sedimentary beds are a result of structural deformation of a previously horizontally bedded formation. The stress of deformation also causes the solidified rocks to fracture and these cracks and joints are abundant in the Layer Formation. As the rocks fracture due to the intense pressure and temperature increase, the low temperature forming minerals such as quartz and calcite dissolve. The solution flows along the cracks and solidifies on cooling and as in the Layer Formation, secondary quartz and calcite crystallise to form veins.

EXPEDITION EXPERIENCE

The following is a light-hearted description of the realities of fieldwork in jungles of Sarawak.

Site Investigation 1

Having arrived at Nanga Sumpa, with my Iban friend and interpreter (Leslie Impi Awak David), equipped with hammer, compass-klino (essential tools of the trade) and some token technology — a Geographical Positioning System (GPS) — we were shown the site of the clay quarry by two of the female potters. To reach the site we weaved through pepper plantations, followed muddy paths through dense jungle, cut through Lalang grass and scrambled up overgrown riverines, wiping rivers of pouring sweat induced from the intense heat and 100% humidity. Having been indoctrinated by endless wildlife television programmes as a youth, my expectations of the jungle was of one teaming with life, creatures ranging from rodents to tigers inhabiting every niche imaginable. Therefore contrary to my vivid imagination, the mammals, birds, amphibians were conspicuous by their absence. What I'd forgotten, however was as a consequence of this abundance of life, camouflage and secrecy is the essence of survival and of course our plodding feet were hardly conducive sounds to our shy furry and feathered creatures. Therefore only the sounds of hidden naturalist pleasures were to be experienced, and these were almost obscured by the constant wining of the Cicadas, which echoed through the jungle. What one could fully appreciate however, were our insecta friends, which constantly nibbled at my tasty pale skin, of which no amount of insecticides could blemish the taste. This minor irritation, however could not deflect from the breathtaking sight and smell of the vegetation, whose draping vines and sprouting parasitic flora adorned the imposing trees that made-up the mass of rich greenery of the jungle.

When finally reached, the site was located at the base of a small waterfall in one of the small riverines. The clay was being quarried from a 60 cm thick gouge in a horizontally orientated, thick blue/grey mudstone bed. Having become disorientated by our meanderings, we confidently reached for the GPS to aid our predicament. The GPS is a small piece of equipment which uses an aerial to link up with overhead satellites (3 or more) to obtain the longitude and latitude of one's position (it is accurate to approximately 100 m). Sadly owing to our predicament, surrounded by dense vegetation, no satellites could be reached and therefore our position was to remain a mystery. Even the trusty compass was of little use, as the overlying canopy shrouded any topographic features, which could have been sighted on. So geographically unenlightened, we proceeded to prospect for more clay.

Only the top 10–15 cm of the mudstone bed was suitable for pottery because of the finer nature of the material and the present exposed clay was almost exhausted. Therefore, having determined the deposit formed in a bed rather than a fault gorge, and knowing that these types of beds are laterally extensive, tending to blanket topography, we took the strike and dip of the bed to determine the projection of the quarry. Once the orientation of the strike was determined, a bearing was sighted in to the distance and an imaginary line followed, in this case following the marker bed. Logically we began close to the present site, on the opposite side of the riverine. The vegetation was cleared from the exposed outcrop only to disclose an already excavated pit used by former potters, which was, sadly, already exhausted. Adjacent to this site was the steep margin of the riverine bank; although clay was exposed it was found to comprise slumped chaotic material unsuitable for potting. Therefore, without the additional aid of a mechanical digger to excavate deeper into the bed, the present site was not likely to yield more clay.

Undemoralised, we continued our search for the elusive clay. Unable to follow the bed laterally owing to a steep, densely vegetated embankment, we decided to investigate the adjacent locality in the neighbouring riverine. This concluded, one of the female potters remained as we clambered to the next site. Knowing that both the GPS and the compass were redundant, the substitute plan was to align ourselves with the voice of the remaining potter at the first locality by calling across the riverine ridge. This plan was quickly halted when we learned that according to Iban belief it is a taboo to shout in the jungle. So drawing on my Geological education I tried to identify any distinctive beds remembered from the first site, which would help locate the position of the potters bed. However, due to the often rhythmically cycled nature of a turbidite succession, locating the exact position in the sedimentary unit would be difficult. This work was also hindered by the lack of outcrop exposure and denser vegetation covering the riverine banks.

So after some thrashing about with the parangs and some random hammering we abandoned the mission and returned to the longhouse sweaty and muddy and slightly demoralised. However the local potters had grasped that with more time they could continue searching along the plane of the bed in adjacent riverines.

Site Investigation 2

The next day faith returned revitalised with the dawn, stimulated by a refreshing swim in the babbling stream accompanied by the morning chorus of the forest wildlife, which resonated through the jungle. Our sleep had been prematurely interrupted by an alarm clock which comprised a cacophony of manic grunting and crazed crowing emanating from the pigs and cockerels located below our raised bedrooms. After bathing, our breakfast — surprisingly Western fare — was duly waiting for us, although we had not seen a soul. The breakfast comprised some fresh bread, kindly fetched by the headman from the local town approximately 30 km down river and fried eggs from the resident chickens.

Once more equipped with tools of the trade (even if they were superfluous to the task in hand) we commenced the sequel to mission 'Potters Clay'. Our first task was to traverse the very steep and narrow steps out of the longhouse and negotiate our way through small children and farm life to the awaiting engine-powered long boat. A whole posse of spectators had gathered, intending to attend the day's 'jolly' on the river to Site 2, as it was formally known. The trip up river was an hour of visual delights, the banks being lined with the brilliant greens of the majestic forest. Often opposing this backdrop was the vivid colours of King Fisher, which regularly glided past. The serenity of the backdrop contrasted with our hindered navigation of the shallow braided river, as we sat nervously scraping over imbricated pebbles and shuddering over turbulent riffles. Our apparent sedate manner being interspersed with manual work as we pushed the boat over hydraulic jumps and wading through waters racing across gravel bars. However, the excitement was soon over, when we found ourselves near a rock outcrop exposed at the margins of a deep pool situated at the inner bend of one of the sinuous meanders. Our position was again unknown, owing to the limitations of the GPS caused by the forest canopy and the inability to consistently read the sodden map from our adventurous boat journey; but it was 'guesstimated' we were approximately 15 km up river. Our proximity to the long house or Site 1 could not be gauged without further investigation.

Having clambered out of the boat, followed by the pose of spectators who were now all perched precariously on a thin ledge of the outcrop, I tried to carry out the procedures of the day before. The site again comprised of interbedded muds and sands, but in contrast to the previous site where only the top 10–15 cm was suitable for usage, here numerous thin bedded muds, approximately 15–20 cm thick, were exposed. However I was shortly informed by my interpreter that the problem at Site 2 was not abundance but in fact the nature of the clay. The mudstone composition contained a greater proportion of silt and sand in comparison to Site 1, thus rendering site 2, a poor substitute for Site 1. Flummoxed and knowing that short of a miracle, the sand could not be removed from the clay *in situ*, we took a sample before returning to the boat.

A Geological Explanation

Over a long period of time, sediments deposited in a turbidite system form an ever-thickening sedimentary sequence as successive beds accumulate vertically. The weight of the sediment is one-reason ocean basins subside, thus ensuring preservation of the beds *in situ*. One factor controlling the characteristics of the bed or type of depositing sediment is the nature of the prevailing environment. Within a fluid system there is much meandering and avulsion (channel switching) as the sediment-laden waters follow the path of least resistance to their destination. Over the short term, previously deposited sediments produce topographic mounds on the basinal slope, these highs obstruct the path of the successive flow causing the channel to change its course and thus coarse particles to shift laterally. Therefore, a previously sandy channel bed could be overlain by muddy overbank deposit.

Alternatively, but less likely in the short term, is sea level change. As sea level falls, the distance of the depositional site to the shoreline reduces and thus the distance of the site from the source of sediment. This allows coarser particles to reach further into the basin and a previously muddy site may become silty. The longevity of these depositional systems is such, that both these explanations for bed compositional changes (i.e. sand to mud) are rhythmical, and will be repeated continually throughout the sequence (see Pickering *et al.*, 1989).

Having noticed, even amongst all the turmoil of the river journey, that the beds lining the riverbank had become sandier and thicker, it was unsurprising the mudstones had become siltier. However, it was felt it would be pointless to continue up or down river searching for other sites, as the specifics of the potter bed relies not only on geological factors, such as sedimentation, not to mention regional metamorphism, but on other natural components, such as weathering and erosion. It was also thought that generations of potters would have had ample time to search the surrounding area for additional clay deposits. So as we returned to the longhouse, in a much swifter manner, I was able to contemplate the problem in hand. Finally, it was thought the best possible solution would be to teach the potters a very simple method of sediment segregation (see Tucker, 1988). In the absence of sedimentation tubes, a glass coffee jar was used. A small sample of mudstone was placed in the jar, with additional water. The lid was placed on the jar and the container shaken until all the sediment became suspended in solution. Owing to the nature of sedimentation, the heavier and normally coarser particles settled first followed by the progressively lighter/finer materials. Whilst the coarser material settles in seconds, the suspended clay can take hours. So after a few false starts (primarily due to children liking the look of this new toy) the container was allowed to rest. The principle being that the potters could repeat this experiment on a larger scale, pour off the excess water and collect the upper sediments for potting.

Having completed this pantomime with mud, water and children, I was promptly sold a pot, made of the very clay in question, given a glass of Tuak and the matter of the potters clay promptly forgotten.

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