This report is an addendum to the “Bedrock Geology of the South Island Aggregates Stebbings Road Quarry” by Kirk Hancock, P.Geo. It updates the geological background, presents new mapping of the adjacent “Butler Quarry”, and includes geological comments for the South Shawnigan area.

1. Regional Geology update

The SIA quarry is underlain by Wark gneiss bedrock (see original report, Section 4). Recent studies on Vancouver Island by Canil et al., (2010, 2012) has determined that the Wark and Colquitz gneiss as mapped by Muller (1983) are variants the same unit. These rocks are now defined as part of a deep crustal sequence of interfingering dioritic intrusions that formed at the root of the Bonanza arc, collectively comprising the West Coast Crystalline complex. Primary igneous textures are predominant and record intrusion at depth. Locally, such as at Cattle Point, rafts of older metasedimentary rocks are engulfed by diorite, likely representing blocks entrapped during intrusive processes. Similarly, blocks of carbonate have been documented near Port Renfrew. Although previous interpretations that the Wark and Colquitz gneiss are entirely metamorphosed sedimentary or volcanic rocks are no longer considered valid, the original names are used herein to maintain continuity with other studies and common usage.

Detailed mapping by this author close to the SIA quarry and reconnaissance work beyond indicate only dioritic gneiss of intrusive origin is present. Compositional layering observed by the author and other researchers indicates layering in the south Shawnigan area is sub-vertical. Mineral assemblages are consistent with a diorititic parentage. Minerals including garnet, tremolite and actinolite, typical in metamorphed carbonates, are notably lacking. Evidence of any carbonate unit in the mapped area is lacking.

Although drill logs reported over 300 feet (100 metres) of “limestone”, this is inconsistent with surface geology. Furthermore, the ‘limestone’ was merely named and not described. Moreover, the drill log identified 'granite", which also is lacking in the area. The log noted that the 'limestone' and 'granite' had the same drilling properties, which is unlikely given that limestones are extremely soft. Hence we consider that the ‘limestone’ was mis-identified by drillers with inadequate geological training.

2. Butler Quarry and area mapping

The author mapped the area of the "Butler Limestone Quarry", 900 metres west of Stebbings road and 750 metres southwest of the SIA aggregates quarry, on April 09, 2013. It is owned and operated by Butler Brothers, a long standing, local aggregate and redi-mix supply company. The quarry is mined mostly for carbonate to produce agricultural lime for local use. The operation is episodic, extracting carbonate as stockpiles are drawn down. The quarry comprises three openings called the "Old" quarry (mined in the early 1900s), the "New" quarry (currently producing carbonate) and the "Granite" quarry (currently producing diorite). No equipment was onsite at the time of mapping.

The "Butler Limestone Quarry" comprises a wedge of carbonate bounded by a shear zone within the Wark gneiss that extends for about eight kilometres along strike. The trace of the shear zone is exposed at several locations, from Wrigglesworth Lake in the southeast to the Butler Quarry itself. Included in the trace of the shear zone are Elkington, and Devereux lakes. Carbonate is exposed at each of the lakes; the Butler Quarry is within 150 metres of Muskrat Lake. The shear zone generally trends NW-SE and is subvertical to steeply west dipping.

The carbonate at the quarry comprises variably mottled grey through white marble. The marble is fine grained and all original textures have been destroyed by recrystallization. Interwoven through the marble are centimetre scale anatomising webs of black material. The rock releases a strong, fetid odour when broken, suggesting that the black material represents an insoluble organic residue concentrated due to solution of carbonate during recrystallization. The marble is well fractured along the trend of the fault. Fracture spacing is typically on the centimetre to decimetre scale and is curviplanar at metre scale [Photo 1]. In several places, the marble exhibits brittle fracture faces with entrained fragments and gouges. Photo 2 shows a face where this is well developed.

Metre-scale tabular bodies of host diorite, either dikes or faulted slivers, are in the marble. The bodies are moderately to significantly altered to chlorite, and in a few places, completely altered to chlorite [Photo 3].

The marble wedge is bounded by massive and uniform diorite. On the west is a zone, one to two metres wide, consisting of closely spaced fractures within the diorite. Beyond that, the diorite is massive and not visibly deformed. The eastern boundary of the quarry is similar

though less well exposed. Approximately 40 metres to the east, in the “granite quarry” a zone of highly strained diorite with well developed cataclastic textures, about 3 metres wide, is exposed. Local black, fine-grained material within the zone shows good, shear parallel boudinage features (stretched and separated layers of material) [Photos 4 & 5]. The black material has the same appearance as local diorite [basaltic] dykes [Photo 6]. The zone is parallel to the shear hosting the carbonate of the “Butler Quarry”.

In summary, the carbonate wedge at the “Butler Quarry” is sharply bounded by diorite. With a maximum width of 60 metres and a maximum length of 200 metres, the carbonate thins to several metres at both ends, resulting in a lense geometry. Examination south to the edge of Muskrat Lake and north for some 250 metres failed to discover any other carbonate outcrops.

3. Airphoto Interpretation

Airphoto imagery of the SIA quarry and Shawnigan Lake area reveals few significant lineaments. Only major tectonic boundaries, the San Juan and Leech River faults, define marked lineaments. Secondary structures, including the Survey Mountain and Shawnigan faults, are visible but typically difficult to distinguish over their full lengths. Tertiary faults/shears, like those exposed at the Butler quarry, have little to no surface expression. Other features apparent in the imagery include the blocky bluffs commonly associated with jointing in massive units like intrusions. The bluffs typically display spacing on the scale of several hundred metres in the SIA and Butler quarry areas. Other features, such as drumlins (features resulting from glacial erosion and deposition) that are visible on the ground have no airphoto expression. Note that forest cover and human disturbance from rural domestic, commercial and industrial activity significantly obscure underlying features throughout the area.

4. Summary

The weight of outcrop evidence indicates that bedrock in the south Shawnigan area around the SIA and Butler quarries is massive diorite of the West Coast Crystalline Complex. There is no evidence of inclusions of other rock in the area. The carbonate exposed near Muskrat, Devereux, Elkington, and Wigglesworth lakes are part of a single shear zone. The carbonates are recrystallized marble and wholly contained within a shear as discrete slivers. For the purposes of hydrological modelling, the rock mass below the SIA quarry is a massive intrusion.

References:

Canil, D., Styan, J., Larocque, J., Bonnet, E. And Kyba, J. (2010): Thickness and Composiiton of the Bonanza Arc Crustal Section, Vancouver Island, Canada; Geological Society of America Bulletin, 122, pages 1094 – 1105.

Canil, D., Johnson, S.T., Larocque, J., Friedman, R. And Heaman, L.M. (2012): Age, Construction, and Exhumation of the Midcrust of the Jurassic Bonanza Arc, Vancouver Island, Canada; Lithosphere, Volume 5, Number 1, pages 82 – 91.

Photo 1: Curviplanar fracturing
of carbonate in the Butler Quarry

Photo 2: Entrained fragments
and gouges along a fracture face
in the Butler Quarry

Photo 3: Dark, diorite wedges within carbonate and shear zone

Diorite outlined by yellow dashed line

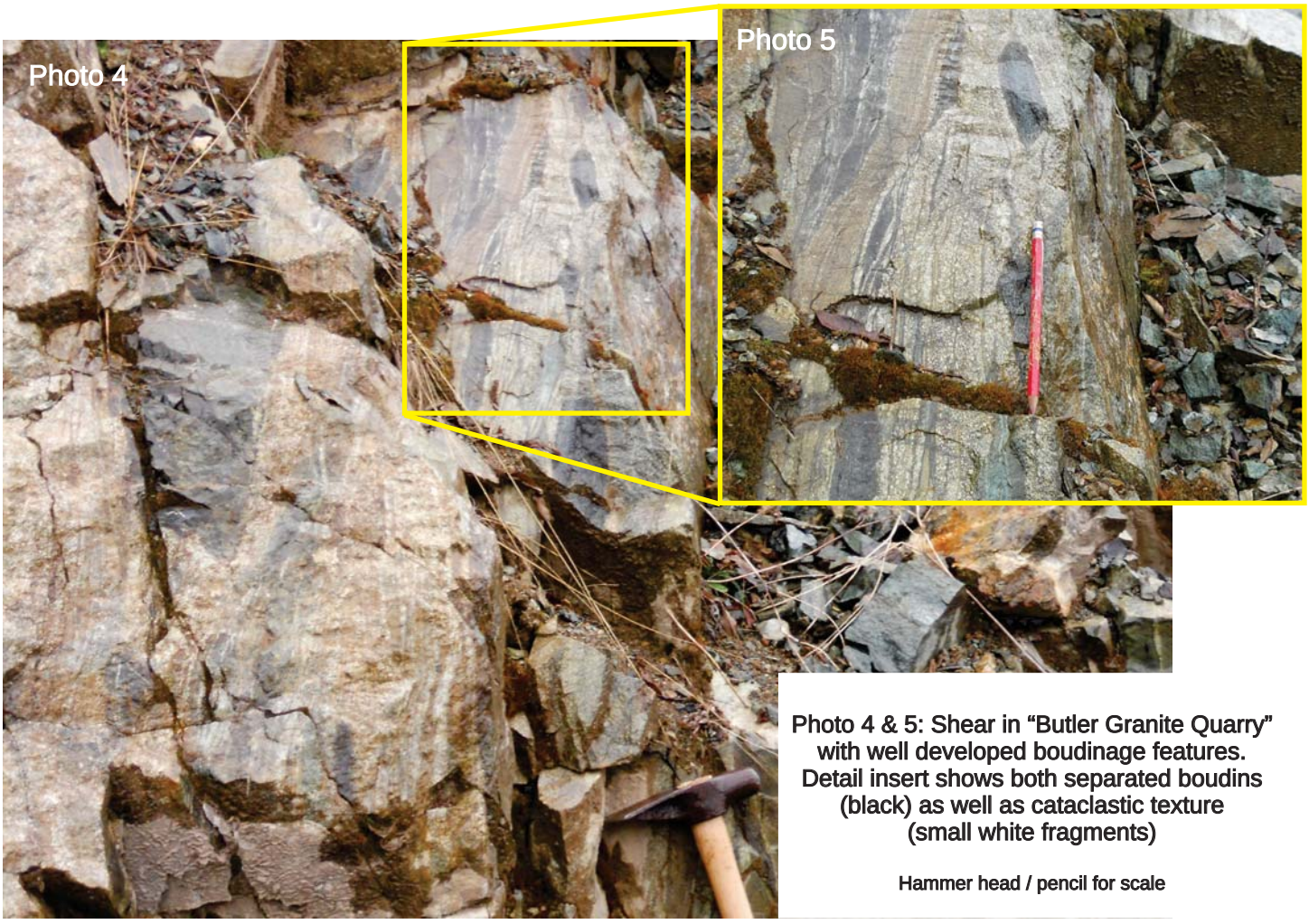

Photo 4 & 5: Shear in “Butler Granite Quarry” with well developed boudinage features. Detail insert shows both separated boudins (black) as well as cataclastic texture (small white fragments)

Hammer head / pencil for scale

Photo 6: Dyke in Wark gneiss diorite

Hammer is 30" long, for scale