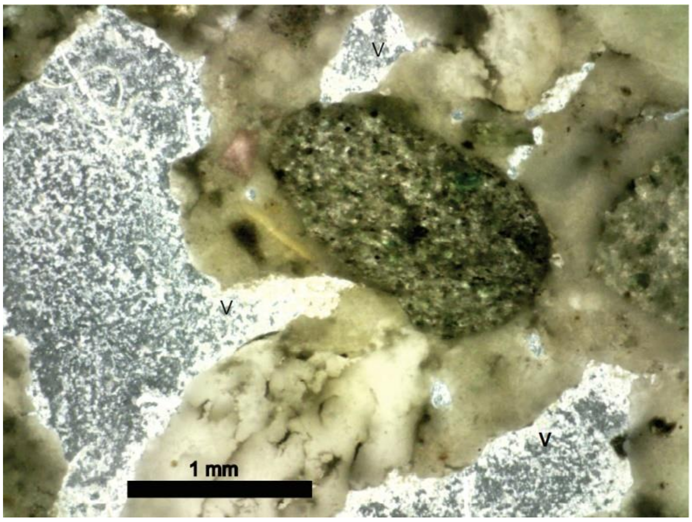
LOWER LIGHTHOUSE, SKELLIG ISLAND, CO KERRY

Lab Report on Geological Analysis of 5 Rock, Mortar and Render Samples



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1 INTRODUCTION

This report was commissioned by Mr Fergus McCormick, senior architect, OPW National Monuments section, Killarney and is concerned with a sample of local rock, two samples of bedding mortar from the interior of Skellig Lower Light House and two samples of external render of the lower lighthouse. Details of the sample are shown in Table 1. The aim of the report is to analyse the samples to establish their composition and to suggest a recipe for replacement mortars.

SAMPLE	LOCATION	DESCRIPTION
1	Fallen Rock	Rock fragment, 45 x 15 x 15 mm
2	1i (internal bedding mortar)	Several fragments of friable mortar, c. 10 x 10 x 5 mm
3	2i (internal bedding mortar)	Two slightly friable fragments of mortar, the lager 40 x 25 x 25 mm
4	1E (external render)	Fragment of render, 40 x 10 x 10 mm
5	2E (external render)	Fragment of render, 50 x 10 x 10 mm

Table 1: Description of samples of fallen rock on Skellig Island and mortars/renders from Skellig Lower Light House.

The report consists of 4 sections, Introduction, Macroscopic Description of Samples of Mortar, Microscopic Analyses of Samples of Mortar, and Conclusions.

2 MACROSCOPIC DESCRIPTION OF SAMPLES OF MORTAR

The samples of fallen rock, mortar and render were inspected under a low powered stereomicroscope. Their colours were matched with chips on a Munsell Rock Color Chart (2009) and with a Munsell web-basedcolour chart.

1. Fallen rock. A strong fragment, bounded by slightly polished surfaces, which correspond to pressure solution surfaces in the thin section described below. The rock is medium grey (N6) and is fine grained, micaceous sandstone.

2. Internal bedding mortar (1i) Individual fragments are friable. On a cut surface the mortar can be seen to consist of varied aggregate grains in a binder, with an overall colour of very light grey (N8) and conspicuous granules of white vein quartz. The binder reacts strongly with 10% hydrochloric acid. The aggregate grains are poorly sorted ranging from granule grade (maximum grain size observed was 2 mm) to medium sand. They are mostly white and translucent quartz but also include sandstone and siltstone. Shell material, particularly violet coloured fragments, probably of *Mytilus edulis* (mussel) is common.

3. Internal bedding mortar (2i) The fragment which was not used to make a thin section consists of cream coloured binder, which reacts strongly with 10% HCl, enclosing coarse sand grade aggregate. On a cut surface the render can be seen to consist of varied aggregate grains in a binder, with an overall colour of very light grey (N8). The binder reacts strongly with 10% hydrochloric acid. The aggregate grains are poorly sorted ranging from granule grade (maximum grain size observed was 3 mm) to medium sand. The aggregate includes dark siltstone and fine-grained sandstone and vein quartz. Shell material, particularly violet coloured fragments, probably of *Mytilus edulis* (mussel) is common.

4. External render (1E): The cut surface of the cohesive fragment shows coarse sand grade aggregate set in a cream coloured binder, which reacts strongly with 10% hydrochloric acid. The aggregate is moderately well sorted, with maximum grain size in the sample of 2 mm. The grains are sub-angular to sub-rounded and are predominantly white to pale yellow quartz with subordinate chert and fine-grained dark sandstone.

5. External render (2E): The cut surface of the cohesive fragment shows very coarse sand grade aggregate set in a cream coloured binder, which reacts strongly with 10% hydrochloric acid. The aggregate is moderately well sorted, with maximum grain size in the sample of 2 mm. The grains are sub-rounded to rounded and are of sandstone, dominantly purple with subordinate quantity of green, and vein quartz.

3 MICROSCOPIC DESCRIPTIONS OF SAMPLES

Individual grains of the internal bedding mortar (sample 1) were mounted in epoxy resin in a cylindrical mould. Plaquettes, suitable for production of a thin section, were cut from the puck containing grains of mortar (sample 1) and the other four samples using a diamond saw, and were cold mounted on a glass slide, reduced in thickness to 30µm and polished. The polished thin sections were examined at differing magnifications in plane light and under crossed nicols using a Dinolite microscope.

Illustrations were composed in Adobe Illustrator.

Sample 1 Fallen rock (Figure 1): The thin section shows a fine grained sandstone, with predominantly angular and subangular grains of quartz with conspicuous scattered large grains (up to 1 mm) of pale green chlorite and flakes of mica. There are anastomosing pressure solution seams.

2. Internal bedding mortar (1i) (Figure 2): It was difficult to make a good quality thin section from this material because of the very large amount of pore space. The binder is fine grained and originally lime based, now consisting of calcite. The aggregate to binder ratio estimated by point counting (200 points) is ~ 4:1. There are numerous pore spaces.

3. Internal bedding mortar (2i) (Figure 3): The thin section confirms the composition of the mortar observed in reflected light, with an aggregate consisting predominantly of well-rounded grains of siltstone and sandstone with common shell fragments. The aggregate to binder ratio estimated by point counting (200 points) is ~ 4:1.

4. External render (1E) (Figure 4): The thin section confirms the composition of the render observed in reflected light, with an aggregate consisting of quartz, some of it polycrystalline, chert and fine-grained sandstone. The modal grain size is coarse sand and the largest grains are 2mm maximum dimension. The binder is lime based and the ratio of aggregate to binder based on point counting (200 points) is c. 3:1.

5. External render (2E) (Figure 5): The thin section confirms the composition of the render observed in reflected light, with an aggregate consisting of haematite- impregnated purple sandstone, green-grey sandstone and quartz. The modal grain size is very coarse sand and the largest grains are 2mm maximum dimension. The binder is lime based and the ratio of aggregate to binder based on point counting (200 points) is c. 2:1.

4 MICROSCOPIC ANALYSES OF SAMPLES OF MORTAR

4.1 Sample 1

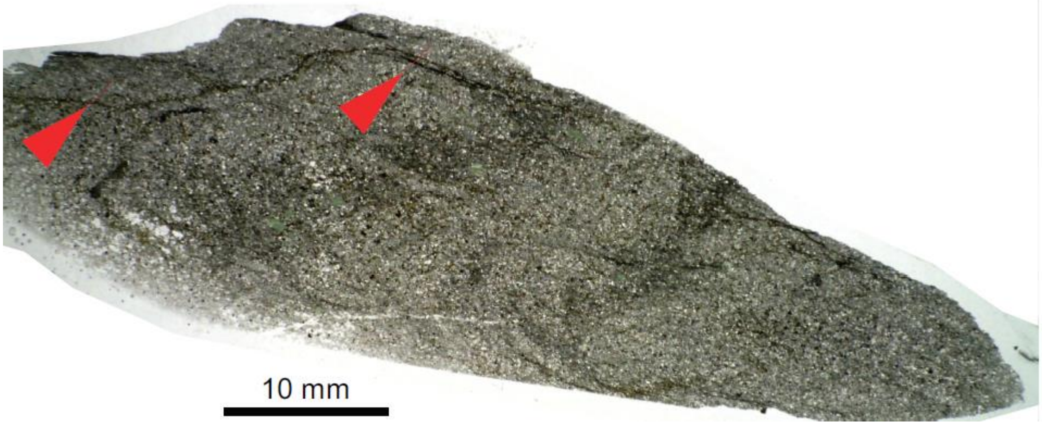

Figure 1a. Low power photomicrograph of Sample 1 (Fallen rock) in transmitted light, showing fine grained sandstone with dark pressure solution seams (arrowed).

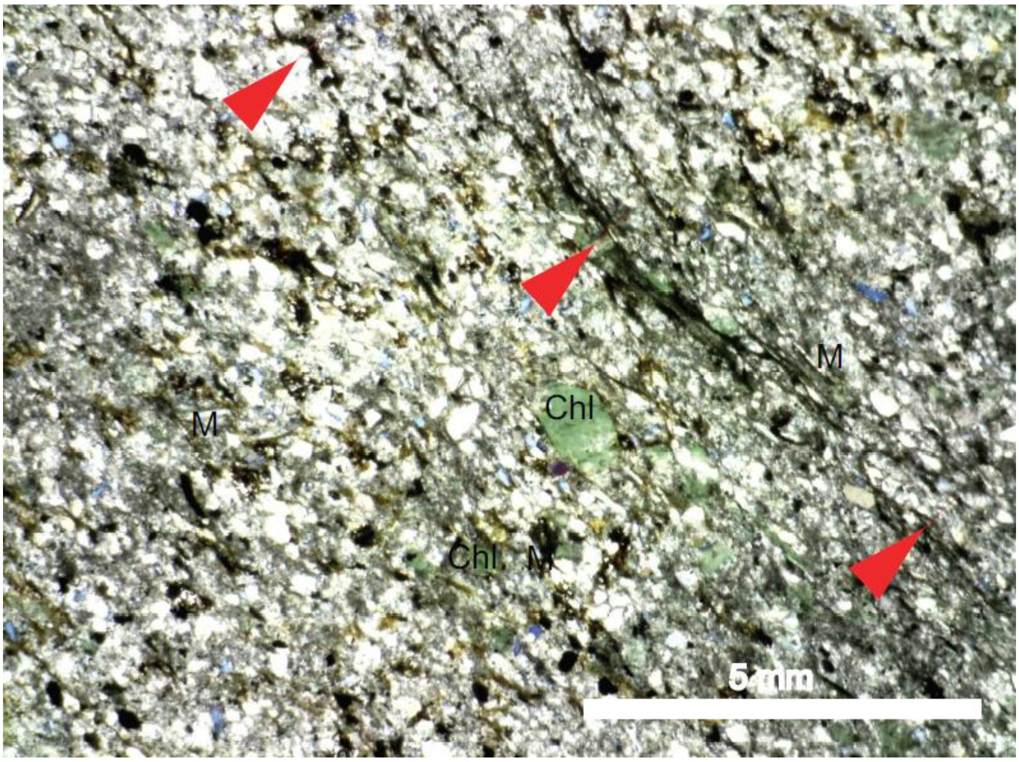

Figure 1b. Photomicrograph in plane transmitted light of thin section of Sample 1 (Fallen rock) showing angular/subangular quartz (clear grains), mica (M) and chlorite (Chl) with pressure solution seams (arrowed).

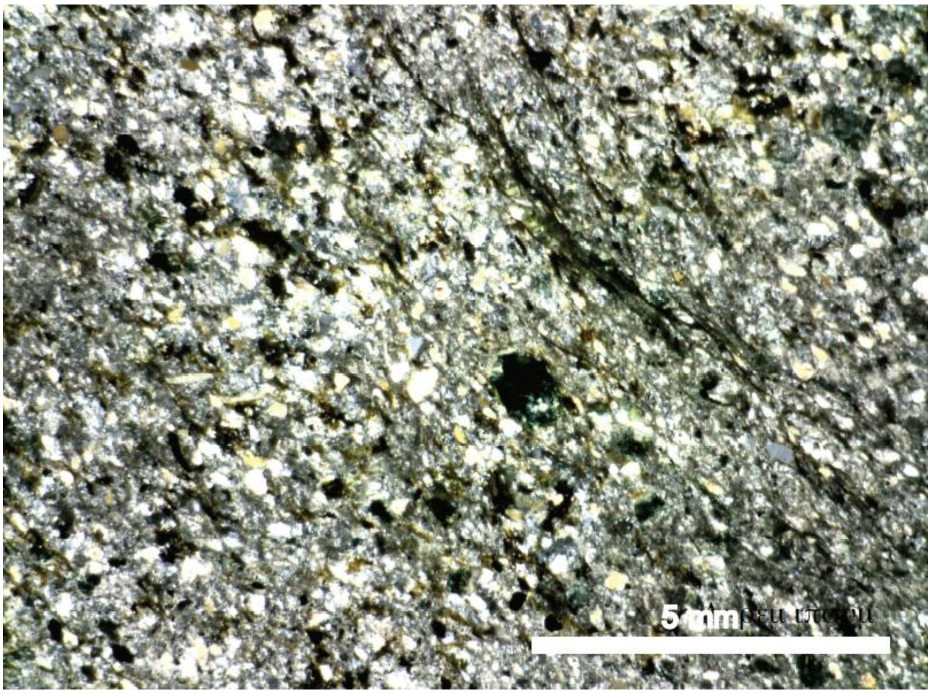

Figure 1c. Photomicrograph in transmitted light and crossed nicols of thin section of Sample 1 (Fallen rock). Same field of view as Figure 1b.

4.2 Sample 2

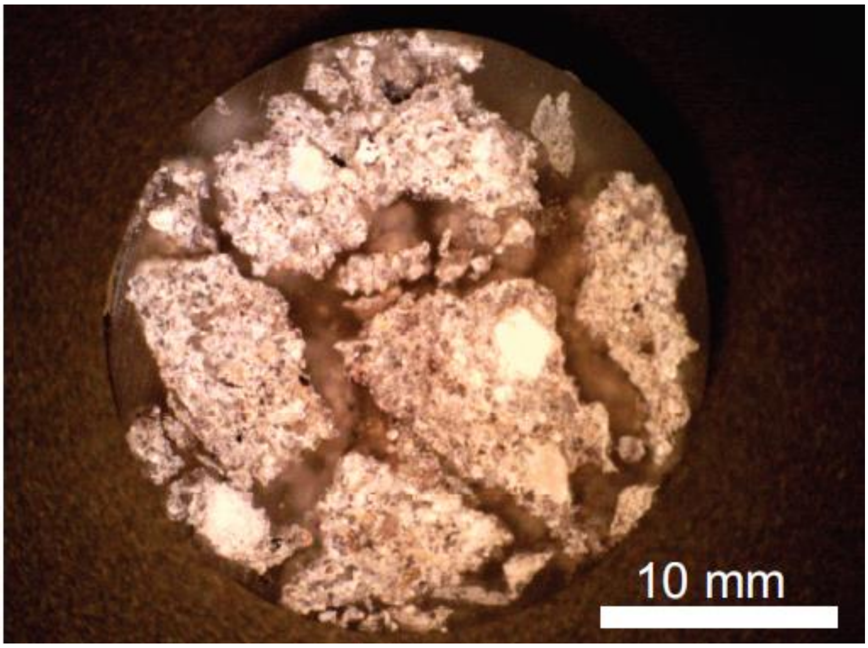

Figure 2a. Low power photomicrograph of Sample 2 (Internal bedding mortar 1i) in transmitted light, showing fragments of mortar mounted in epoxy resin with conspicuous white grains of vein quartz.

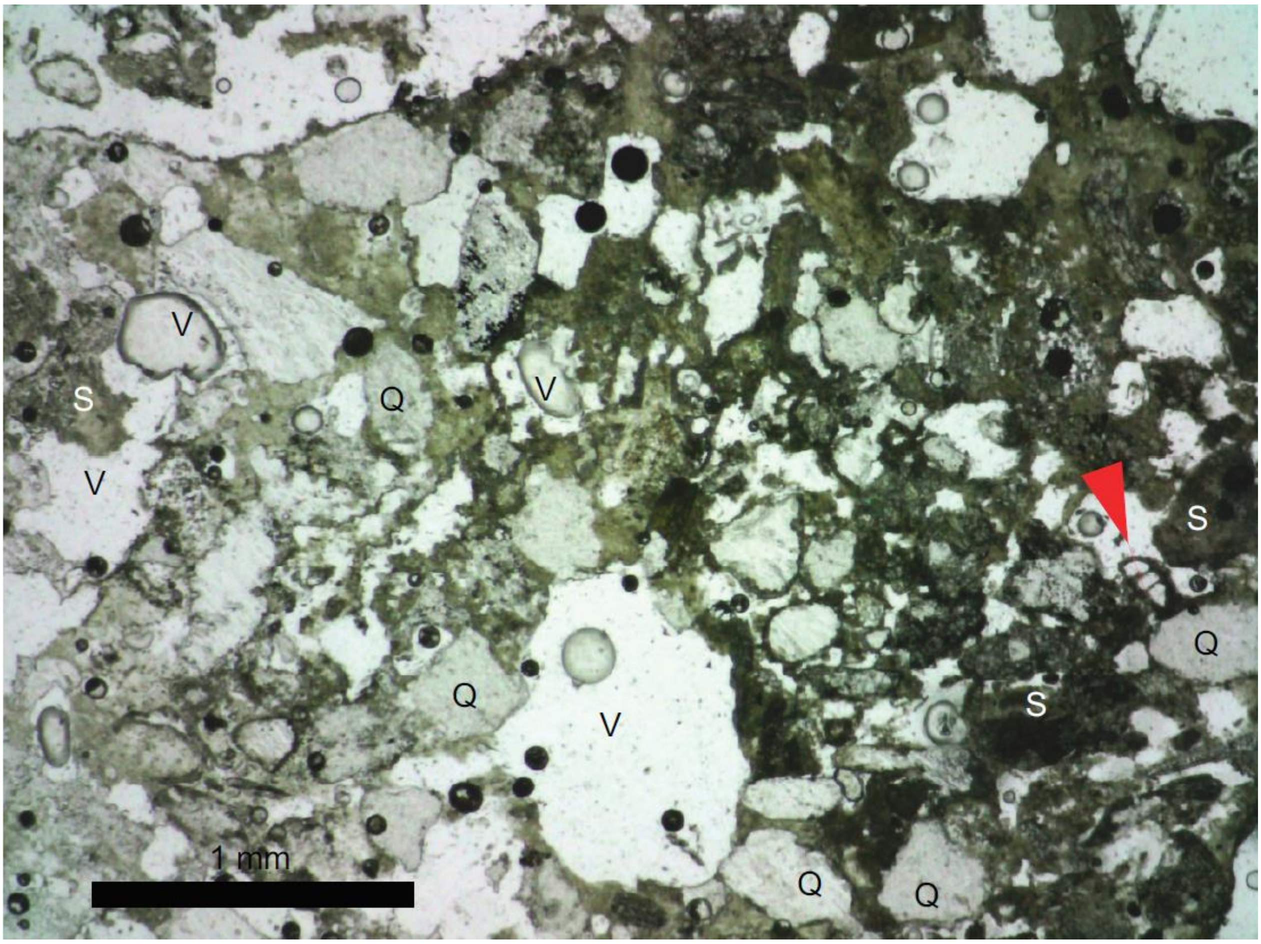

Figure 2b. Photomicrograph in plane transmitted light of thin section of Sample 2 (Internal bedding mortar 1i) showing quartz (Q) and siltstone (S). Voids are marked V. Note the forminiferan (arrowed), that indicates that the aggregate was from a marine environment.

4.3 Sample 3

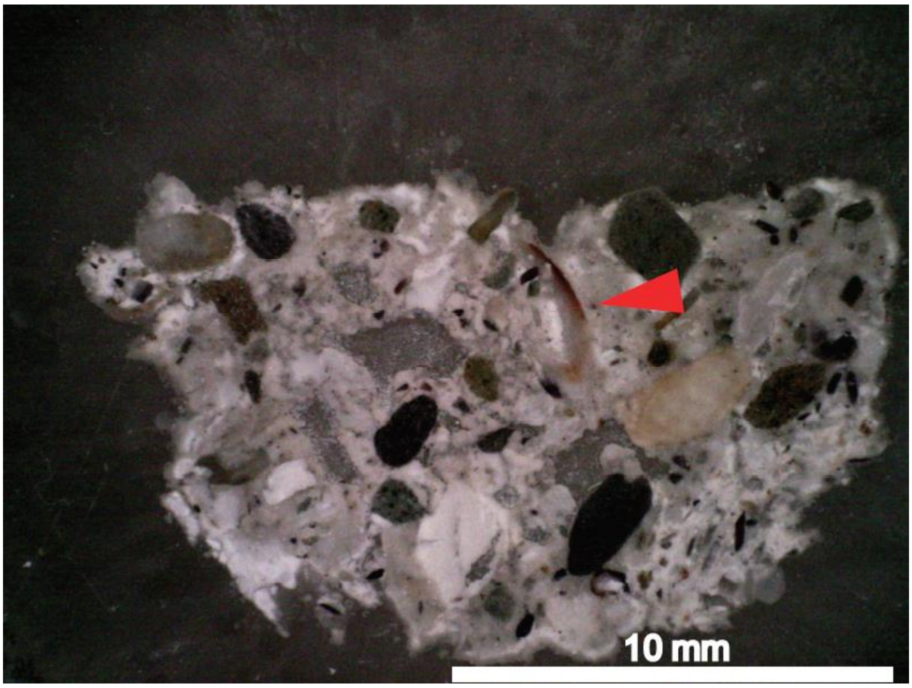

Figure 3a. Low power photomicrograph of Sample 3 (Internal bedding mortar I ii) in reflected light, showing varied aggregate in pale coloured fine-grained binder. Note cross section of shell (arrowed).

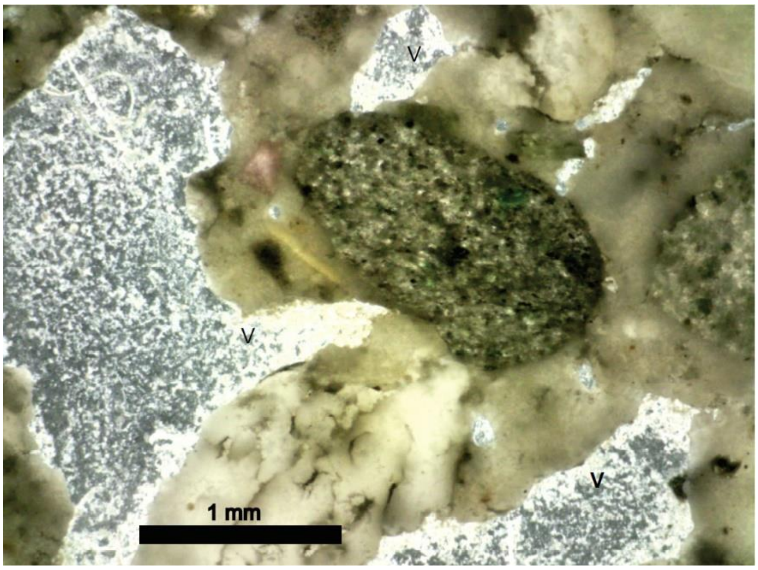

Figure 3b. Photomicrograph in plane transmitted light of thin section of Sample 3 (Internal bedding mortar I ii) showing very coarse sand grade grains of siltstone. Voids are labelled V.

4.4 Sample 4

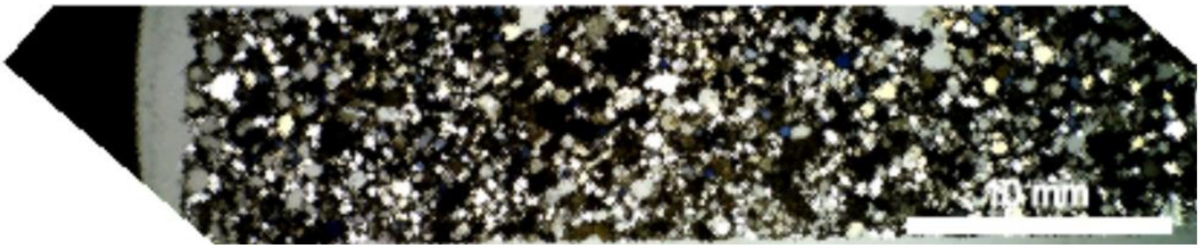

Figure 4a. Low power photomicrograph of Sample 4 (External render 1E) in transmitted light, showing sand grade aggregate grains (clear) in fine grained binder

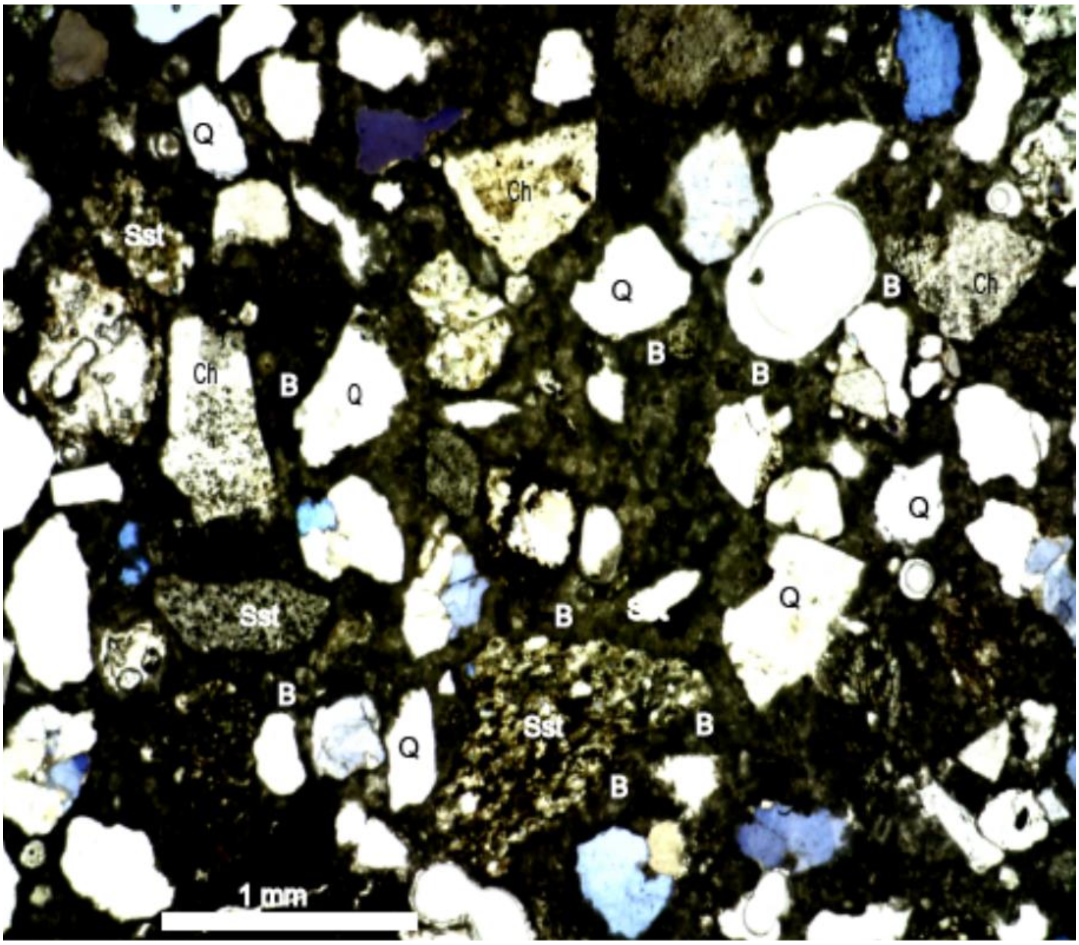

Figure 4b. Photomicrograph in transmitted light and partly crossed nicols of thin section of Sample 4 (External render 1E). showing grains of quartz (Q), chert (Ch) and fine grained sandstone (Sst) in fine grained binder (B)

4.5 Sample 5

Figure 5a. Low power photomicrograph in reflected light of Sample 5 (Exterior render, 2E), showing dominantly purple sandstone aggregate in fine grained binder.

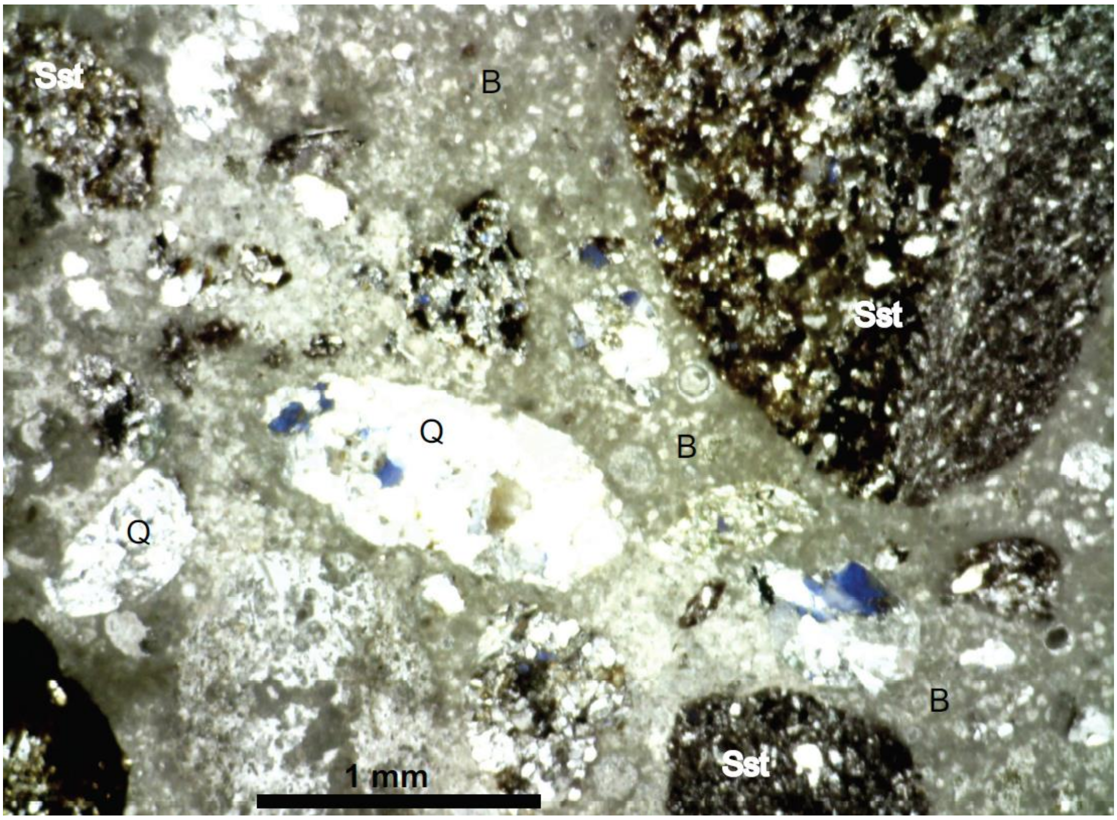

Figure 5b. Photomicrograph in plane transmitted light of thin section of Sample 5 (Exterior render, 2E) showing rounded grains of purple sandstone (Sst) and quartz (Q) in a fine-grained binder (B).

5 DISCUSSION & CONCLUSION

Sample 1 (from fallen rock): This is a fine-grained micaceous sandstone, typical of the Munster Basin. The geology of Skellig Michael is reported (Logitech.co.uk) to consist of rocks of the St Finans Sandstone Formation separated by a fault from siltstones of the Caha Mountain Formation.

Samples 2, 3 (internal bedding mortars): These both comprise lime-based binder with an aggregate derived from beach sand, screened to exclude particles > 3mm. The source of the beach sand is not certain, but the composition of the aggregate is consistent with a source in west County Kerry. Suggested replacement mix should use a ratio of 3 parts aggregate to 1 part binder.

Samples 4, 5 (external renders): The two samples of render differ both in the aggregate used and the proportion of aggregate to binder. The aggregate in sample 5 is dominantly quartz, pale coloured chert and fine-grained sandstone, whereas the aggregate of sample 5 is predominantly purple sandstone. The ratio of aggregate to binder is 3:1 in sample 4 and 2:1 in sample 5. Replacement renders should respect the different aggregates, both of which should be available in west County Kerry.

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