Mortars for Historical Masonry -Part 2 Appendices and Graphics

1 Mortar mixing

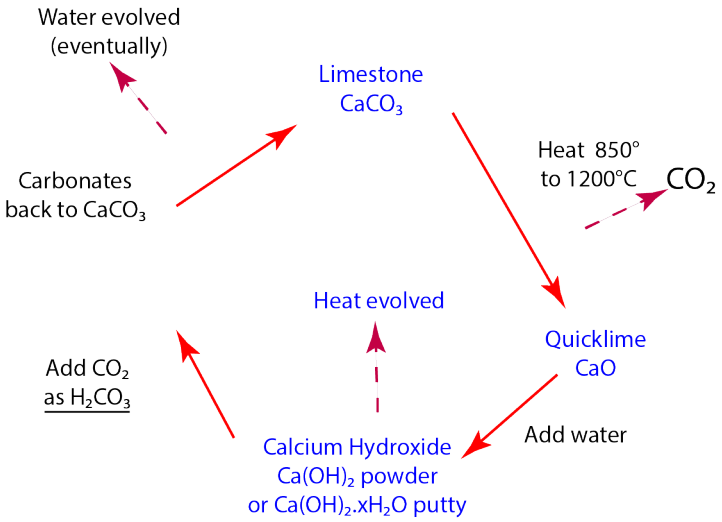
Photo 1 *A mortar mill mixing "hot lime" mortar during conservation works at Canterbury Cathedral. Note steam from the sand slaking of quicklime.*

2 **Sand grading** (after British Standard BS 1200 Sands for mortar for plain and reinforced brickwork, blockwork and masonry).

Sieve Size	% passing min. by	% passing max. by
4.7	9	10
2.3	8	9
1.1	5	8
0.6	2	3
0.3	2	1
0.1	0	5
0.07	0	2

Photo 2 *Close up of a well-graded mortar sand. Note coarse particles. The good grading aids workability and no additives should be needed.*

3 LIME CYCLE



The "lime cycle" is found in many publications. As usually seen, it implies that CO_2 acts without water being present: this is not the case. If mortar is not wet cured, it desiccates rather than cures, particularly in hot Australian weather.

Fig 1 Lime Cycle.

4 Lime and Cement Compositions.

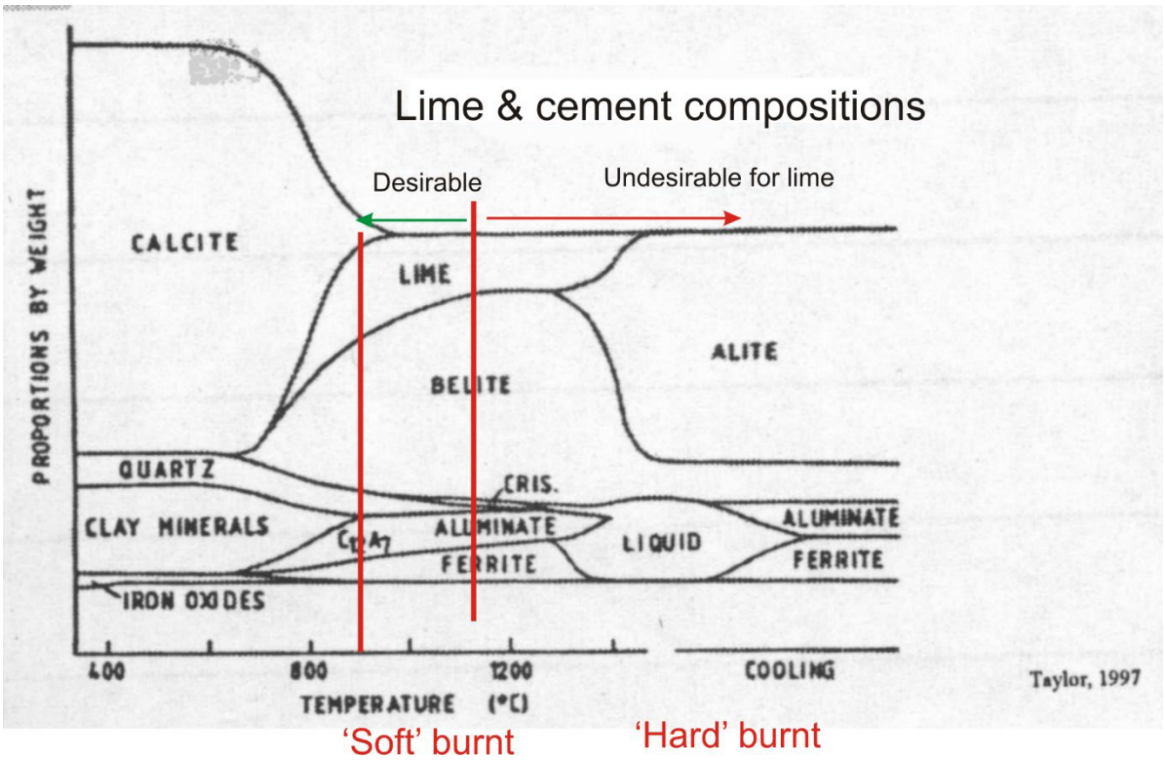


Fig 2 Lime Cycle Diagram from Taylor, 1997 and many other sources; (additions in RED by the EHA author)

5 Classification of hydraulic limes and cements.

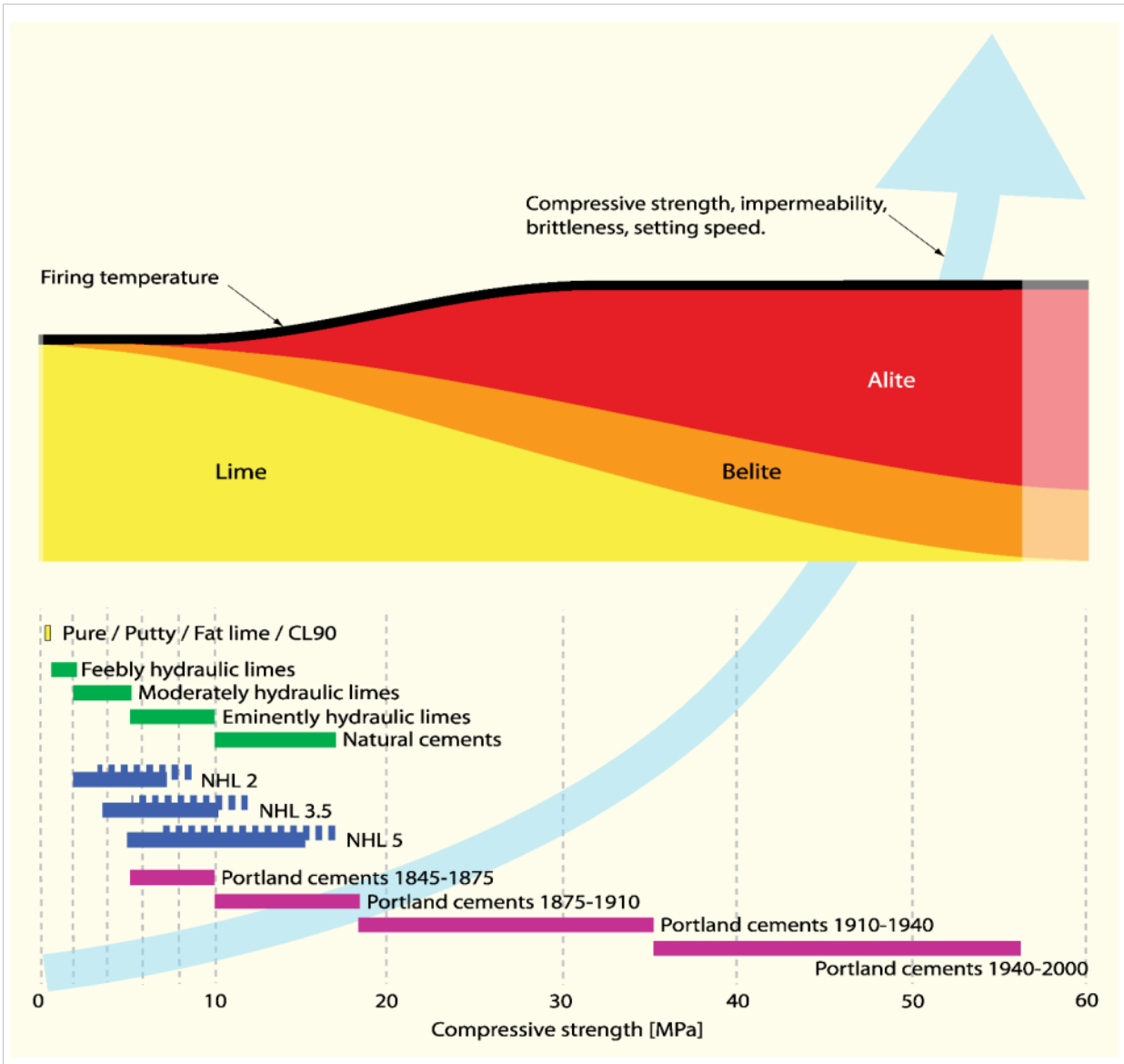


Fig. 3 Classification of hydraulic limes and cements *(Diagram originated by Ian Brocklebank and published by Building Limes Forum, UK. Used with permission of BLF).*

This diagram refers to two means of classifying hydraulic limes, the original Vicat classification and those to the modern European standards which are imported into Australia. NHL2 is generally the most suited to historical masonry as the others cure to too high a strength.

'Belite' is dicalcium silicate (C2S in cement chemistry terms) and alite is tricalcium silicate (C3S). There should be little or no C3S in hydraulic lime for use in historical masonry.

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6 Some Illustrations.

Photo 3

An 1830s convict-made lime mortar (Campbelltown). The small white particles in the matrix indicate that it was hot-mixed. Shell fragments can also be seen, which may have come from incomplete burning. But as not sign of burning is seen on many it probably indicated that they were incorporated in the mix to give the sand better grading.

Photo 4

An 1840s mortar in the Hunter Valley, which is mainly loam, but with some hot mixed lime for additional binding. Lime was scarce in the region at the time. Some buildings of the era even used clayey loam for wall plastering with only a thin lime set coat.

Photo 5

Strong hydraulic lime mortar from a c. 1860 railway structure. The face of the brick failed rather than the joint when they were prised apart. Late 19th Century railways brickwork has yielded flexural bending characteristics strengths up to 1.8MPa. This compares with a maximum allowable for OPC mortars of 1MPa

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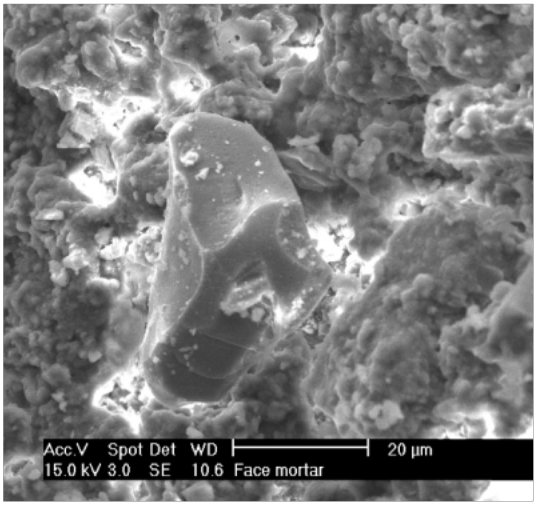
At a microscopic level, the following helps explain. Portlandite is crystalline Calcium Hydroxide, $Ca(OH)_2$ and is modified by the trace elements from hydraulic elements.



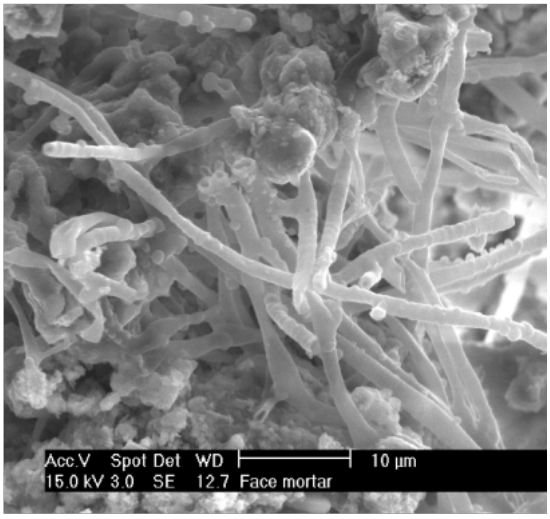


Photo 6 ***Photo 7***

The "fluffy paste" of some portlandite forms (Photo 6 on the left) and strands often seen (Photo 7 on right). The tubular nature of the strands (not reported in literature, this is Uni. Of Newcastle Sem for the EHA author) may help carbonation.