*Supplementary B – Statistical Analysis*

**Supplementary Table 1:** Two-way ANOVA values comparing thickness loss measurements between the two pH treatments for each microstructure. P values that show significant difference between the treatments (at the 95% confidence interval) are in bold.

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|  | ANOVA values |
| Nacre (Aragonite) | F = 34.23**p = 1.61e-7** |
| Composite prisms (Aragonite) | F = 1084.31**p = 1.51e-45** |
| Crossed-lamellar (Aragonite) | F = 62.93**p = 1.18e-11** |
| ‘Homogeneous’ (Aragonite) | F = 40.40**p = 2.92e-8** |
| Columnar prisms (Calcite) | F = 72.52**p = 7.21e-13** |
| Fibrous prisms (Calcite) | F = 71.03**p = 2.21e-12** |
| Foliae (Calcite) | F = 46.62**p = 6.15e-9** |
| Lobster cuticle (Calcite and α-chitin) | F = 1.30p = 0.26 |

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|  | AmbientAll Samples | AmbientBivalves Only | ReducedAll Samples | ReducedBivalves Only |
| Organic Content | R2=0.839Sig. F = 5.3e-112 | R2=0.087Sig. F = 3.2e-6 | R2=0.881Sig. F = 7.1e-142 | R2=0.016Sig. F = 0.041 |
| Mg/Ca | R2=0.805Sig. F = 2.1e-100 | R2=0.415Sig. F = 1.6e-29 | R2=0.846Sig. F = 1.7e-124 | R2=0.144Sig. F = 1.8e-10 |
| Crystal Density | R2=0.017Sig. F = 0.031 | R2=0.130Sig. F = 9.0e-9 | R2=0.030Sig. F = 0.002 | R2=0.236Sig. F = 4.6e-17 |
| Mineralogy | R2=0.122Sig. F = 1.9e-9 | R2=0.439Sig. F = 1.0e-31 | R2=0.107Sig. F = 5.6e-9 | R2=0.268Sig. F = 1.4e-19 |
| Organic Content + Mg/Ca | R2=0.844Sig. F = 4.3e-112 | R2=0.417Sig. F = 1.8e-28 | R2=0.888Sig. F = 1.1e-143 | R2=0.151Sig. F = 4.8e-10 |
| Organic Content + Crystal Density | R2=0.841Sig. F = 6.4e-111 | R2=0.150Sig. F = 4.4e-9 | R2=0.882Sig. F = 1.3e-140 | R2=0.257Sig. F = 1.4e-17 |
| Organic Content + Mineralogy | R2=0.843Sig. F = 1.6e-111 | R2=0.477Sig. F = 4.3e-34 | R2=0.884Sig. F = 9.1e-142 | R2=0.361Sig. F = 3.4e-26 |
| Mg/Ca + Crystal Density | R2=0.806Sig. F = 6.4e-99 | R2=0.531Sig. F = 1.2e-39 | R2=0.849Sig. F = 2.4e-124 | R2=0.343Sig. F = 1.2e-24 |
| Mg/Ca + Mineralogy | R2=0.832Sig. F = 9.8e-108 | R2=0.475Sig. F = 7.0e-34 | R2=0.880Sig. F = 2.4e-139 | R2=0.272Sig. F = 9.1e-19 |
| Crystal Density + Mineralogy | R2=0.191Sig. F = 1.9e-13 | R2=0.447Sig. F = 3.6e-31 | R2=0.212Sig. F = 2.7e-16 | R2=0.340Sig. F = 2.4e-24 |
| Organic Content + Mg/Ca + Crystal Density | R2=0.845Sig. F = 7.1e-111 | R2=0.602Sig. F = 5.7e-47 | R2=0.888Sig. F = 3.9e-142 | R2=0.497Sig. F = 1.1e-38 |
| Organic Content + Mg/Ca + Mineralogy | R2=0.844Sig. F = 1.3e-110 | R2=0.510Sig. F = 2.4e-36 | R2=0.889Sig. F = 1.4e-142 | R2=0.366Sig. F = 1.2e-25 |
| Organic Content + Crystal Density + Mineralogy | R2=0.843Sig. F = 3.7e-110 | R2=0.499Sig. F = 3.5e-35 | R2=0.884Sig. F = 3.4e-140 | R2=0.500Sig. F = 5.0e-39 |
| Mg/Ca + Crystal Density + Mineralogy | R2=0.837Sig. F = 8.5e-108 | R2=0.531Sig. F = 1.3e-38 | R2=0.882Sig. F = 5.8e-139 | R2=0.349Sig. F = 3.3e-24 |
| Organic Content + Mg/Ca + Crystal Density + Mineralogy | R2=0.845Sig. F = 1.2e-109 | R2=0.609Sig. F = 1.0e-46 | R2=0.889Sig. F = 1.8e-141 | R2=0.525Sig. F = 5.9e-41 |

**Supplementary Table 2:** Multiple regression analysis values for the two pH treatments both with and without the inclusion of lobster cuticle. Every combination of the measured microstructural characteristics is considered with the strongest predictor combination highlighted in yellow.