The enantiomeric ratios of the amino acids provide a method of determining the ages of the San Diego ironstones. The amino acids show significant racemization with average D/L ratios between 0.21 and 0.29. Heating experiments on the ironstone samples yield a first-order racemization rate constant of ~$3x10^{-4}$ yr^{-1}, assuming an average exposure temperature of 10°C. This gives bulk ironstone ages on the timescale of thousands of years. Because of the time that ironstones take to form, it is highly probable that the ironstone cores are much older than the bulk samples.

Formation Model: The marine terraces formed as wave-cut platforms during times of higher sea level, and the beach ridges accumulated during pauses in the retreat of the sea from the land. Upon withdrawal of the sea, the exposed wave-cut platforms and beach ridges were exposed to Pleistocene climates that were wetter than today. These paleoclimates produced iron and manganese-rich leachates that led to the formation of a subsurface horizon within which ironstone concretions formed in situ. If we accept that the age of Sunset Cliffs sedimentary soils are approximately 100ka, this places an upper age for the formation of the ironstones. Further studies on the Sunset Cliffs ironstone cores and surrounding layers will better define the formation model on a geological timescale.

Conclusions: The San Diego county ironstones appear to be a unique analog to the concretions found upon Mars. Our ironstone formation model requires vertical aqueous activity within sedimentary deposits, which supports the hypothesis that the Mars 'blueberries' require liquid water to form. The visual and chemical evidence of microbial life within these ironstones provides evidence that bacteria may have mediated the formation of concretions in this environment. A more detailed profile of the San Diego ironstones will be presented with the calculated ages of the ironstone concretions and a more detailed explanation of the formation model.

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Figure 2. HPLC chromatograms of total hydrolyzable amino acids (THAA) detected in small (SCS), medium (SCM), and large (SCL) Sunset Cliffs ironstone concretions. 1=D/L-aspartic acid, 2=L/D-glutamic acid, 3=D/L-serine, 4=glycine, 5=β-alanine, 6=γ-aminobutyric acid, 7=D/L-alanine, 8=L-valine, 9=D-valine.