LETTER

# Amino acids in the Tagish meteorite

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In their paper "Evidence for sodium-rich alkaline water in the Tagish Lake parent body and implications for amino acid synthesis and racemization," White et al. (1) make several inaccurate statements about amino acid racemization and prebiotic synthesis. Amino acid racemization in meteorites has been previously discussed in detail (2). White et al. (1) state that during the aqueous alteration phase in the Tagish Lake parent body "aspartic acid. . .would racemize within ~176 d" in warm (80 °C) alkaline (pH 9) conditions. The alkaline pH was deduced from their investigation of the mineralogy of the meteorite. It is not apparent on what basis 80 °C was selected as the aqueous alteration temperature, or how the value of 176 d was calculated and what it implies.

The aspartic acid racemization rates used by White et al. (1) were based on the racemization half-lives (the times needed to reach a D/L ratio of 0.33) in ref. 3 and are for 25 and 100 °C at pH 7 to 8. Aspartic acid racemization is highly sensitive to pH between pH 8 and 10, with the rate increasing by nearly a factor of 10 (4) compared to neutral pH. I cannot ascertain whether White et al. adjusted these half-lives to account for this. I assume the Arrhenius equation was used to calculate racemization rates at 80 °C. If so, what value was used for the activation energy ($E_a$)?

White et al. (1) note aspartic acid is not racemic in the Tagish meteorite. An enantiomeric excess (defined as $L_{ee}$ = L% − D%) of L-aspartic acid of ~43 to 59% has been reported for the Tagish meteorite (5). Does their 176-d estimate indicate that the Tagish L-aspartic acid excess was initially much larger and this has been partly erased by racemization? Isovaline in the same Tagish Lake meteorite samples had an L-enantiomer excess of ~0 to 7% (5). However, this amino acid lacks a chiral α-hydrogen, and thus it would not be as susceptible to racemization, at least in an aqueous environment (3).

White et al. (1) also state that "alkaline solutions. . .support faster synthesis of amino acids," citing ref. 6. However, this reference is for alkaline solutions containing $Fe^{+2}$. Whether the solutions associated with the aqueous alteration phase of the Tagish meteorite contained $Fe^{+2}$ is unknown. White et al. (1) state that the low abundance of amino acids in Tagish is the result of the "absence of another key component (such as aldehydes or ammonia)." In fact, aldehydes and ketones have been detected in the Tagish meteorite (7). In addition, ammonia and hydrogen cyanide have been detected in other carbonaceous meteorites such as Murchison (8, 9). These are the key components for the Strecker synthesis of amino acids that is thought to be one pathway by which amino acids were synthesized in carbonaceous meteorites (3).

Taken all together, this discussion seemingly negates the conclusion of White et al. (1) that the "low abundances of amino acids in Tagish Lake cannot be ascribed to fluid chemistry."

**1** L. F. White *et al.*, Evidence for sodium-rich alkaline water in the Tagish Lake parent body and implications for amino acid synthesis and racemization. *Proc. Natl. Acad. Sci. U.S.A.* **117**, 11217–11219 (2020).
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**5** D. P. Glavin *et al.*, Unusual nonterrestrial L-proteinogenic amino acid excesses in the Tagish Lake meteorite. *Meteorit. Planet. Sci.* **47**, 1347–1364 (2012).
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**7** D. N. Simkus *et al.*, New insights into the heterogeneity of the Tagish Lake meteorite: Soluble organic compositions of variously altered specimens. *Meteorit. Planet. Sci.* **54**, 1283–1302 (2019).
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