will depart from the random NN distribution as much as the measured case.

A random distribution would imply that sites favorable for the nucleation and growth of concretions are ubiquitous and densely distributed through the rock (i.e., all sites have an equal probability of nucleating), or else that favorable sites are themselves randomly distributed. A random distribution of spherules would imply moreover that the nucleation and growth of a concretion does not change the likelihood that other concretions will nucleate nearby. Our results indicate a clear departure from a random distribution. The measured distribution lies below the random distribution for small separations, and this may imply that concretions diminish the likelihood of nucleation in their proximity (e.g., competing zones of depleted solute). Because we find examples of doubly- and triply-fused concretions (Fig. 7f,g) this interference clearly does not occur in all circumstances. An alternate explanation is that favorable sites have a heterogeneous distribution such that they occur in zones with varying abundance owing, for example, to variations in permeability and porosity. Our measurements of a slight major axis elongation (~6%) suggest that fluid transport was very slow relative to the time it took the concretions to grow. Note that this very slight major axis elongation would also include any compaction effects, although these are considered to be minimal.

The regional distribution of concretions place important constraints on their timing. Sedimentary structures indicate that both subaqueous (upper part of upper Burns unit) and aeolian (lower and middle Burns units) facies exist in this sedimentary succession [2]. Within Endurance crater, notably at Burns Cliff, compelling examples of high angle meter-scale cross beds overlain by low angle sandstones are interpreted as dune and sand sheet facies, respectively. Accordingly, an important observation is that concretions also are found in these sedimentary rocks and their distribution is unaffected by major facies boundaries (see Fig. 10). Accordingly, formation of concretions is interpreted to have been sometime after deposition of the entire sequence because the concretions are pervasively distributed across facies boundaries.

The formation of hematitic concretions is not an unreasonable process to expect in a complex and reactive iron and magnesium-rich, acidic evaporite system. The resulting evaporitic mineralogy is highly labile and stability of many of the minerals is very sensitive to pH, oxidation state, ionic strength and composition of groundwater [17,25]. Tosca et al. [17] modeled the effects of fresh water recharge on evaporites precipitated from fluids derived by interaction with olivine-bearing basalts and found that breakdown of jarosite to form goethite or hematite resulted, e.g.:

$$(H_3O)Fe_3(SO_4)_2(OH)_6 \Rightarrow 3FeO{\bullet}OH + 2SO_4^{2-} + H_2O + 4H^+. \quad (1)$$

Another plausible reaction is oxidation of a highly soluble ferrous sulfate, such as melanterite [54], a possible late-stage evaporite mineral [17] and candidate crystal mold-filling mineral (see below), to form goethite or hematite e.g.:

$$FeSO_4{\bullet}7H_2O + 0.25O_2 \Rightarrow FeO{\bullet}OH + SO_4^{2-} + 5.5H_2O + 2H^+. \quad (2)$$

Note that both of these reactions would lower the pH of the groundwater and likely move the system back in the

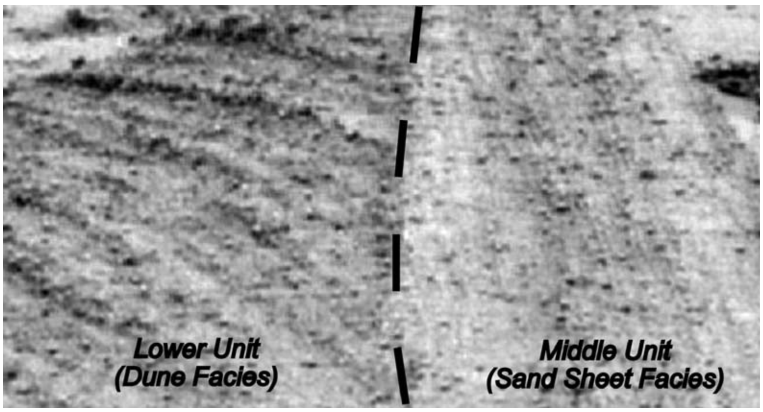

Fig. 10. Close up of grayscale “super-resolution” Pancam image showing the Wellington contact that separates the lower dune facies from the middle sand sheet facies [2]. Note the distribution of spherules on either side of the contact. The scale of the image can be estimated from the size of spherules, which average about 4.2 mm in diameter. Images used to construct this “super-resolution” picture were taken on Sol 288 using the 430 nm filter.