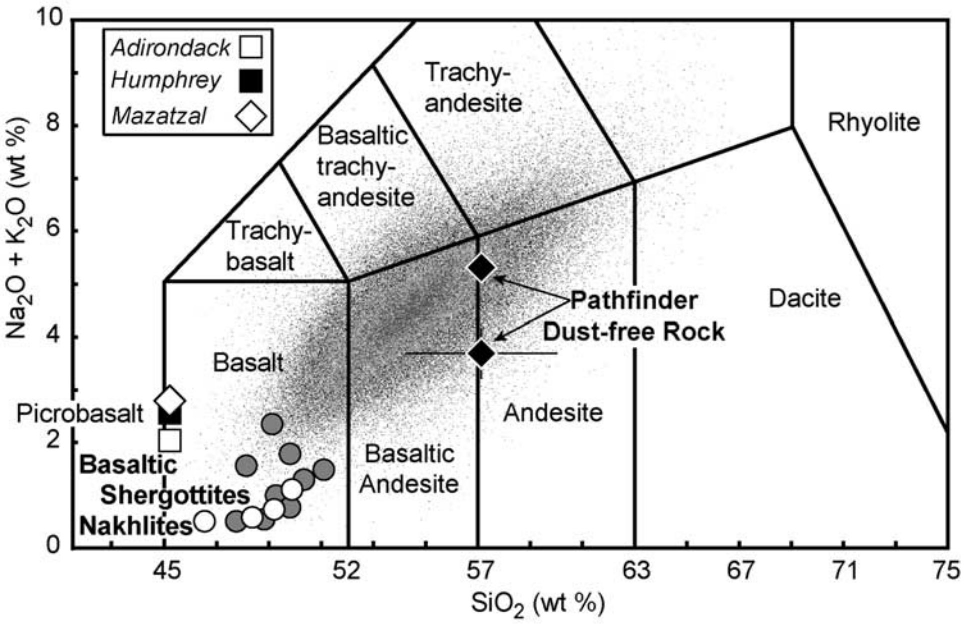

Figure 9. Alkalis versus silica diagram used for volcanic rock classification. Gusev basalts plot on the boundary between basalt and picrobasalt, distinct from Martian basaltic meteorites (shergottites and nakhlites; references in Table 2) and Mars Pathfinder rocks [*Brückner et al.*, 2003; *Foley et al.*, 2003]. The cloud of points represents global surface compositions estimated from TES spectra, as described by *McSween et al.* [2003].

(Dhofar 019 and Yamato 980459) contain euhdral olivine megacrysts having magnesian core compositions ($Fo_{83\text{-}86}$) that are in equilibrium with the bulk-rock compositions [*Taylor et al.*, 2002; *Greshake et al.*, 2004; *Mikouchi et al.*, 2004]. Crystal size distribution (CSD) analyses of olivines for the most part produce linear arrays [*Taylor et al.*, 2002; *Goodrich*, 2003; *Greshake et al.*, 2004], supporting the hypothesis that most olivines formed by continuous cooling without interruption. These data support the hypothesis that the olivine megacrysts are phenocrysts.

[34] A complicating factor is that even Dhofar 019 and Yamato 980459 contain a few corroded, Fe-rich olivines, and their CSD patterns deviate from the linear trend at the largest grain sizes [*Goodrich*, 2003; *Greshake et al.*, 2004]. These unusual grains are possibly xenocrysts or cumulates, but they comprise only a small portion of the olivine megacryst population in each meteorite. A further complication is that, for most olivine-phyric shergottites, the earliest crystallizing olivine phenocrysts (those with compositions in equilibrium with the bulk-rock magma composition) are missing, apparently removed by crystal fractionation [*Goodrich*, 2003]. Taking all the data into account, the most plausible model is that the bulk of olivine crystals in olivine-phyric shergottites are phenocrysts. In many of these meteorites, the earliest-formed phenocrysts have been lost and some small proportion of xenocrysts or cumulates have been added. However, the most magnesian olivine-phyric shergottites like Yamato 980459 appear to represent liquid compositions, or nearly so.

[35] As expected, olivine-phyric shergottites have higher contents of magnesium and nickel than do basaltic shergottites (Figure 13a). Given the model above, this correlation can be interpreted as reflecting the higher magnesium and nickel abundances in primitive magmas, with the trend representing an olivine-control fractionation line. The Gusev basalts Humphrey, Adirondack, and Mazatzal plot near the olivine-phyric shergottites in Figure 13a. All the Martian rocks have higher magnesium contents at a given nickel content than terrestrial mafic and ultramafic rocks (Figure 13a). Gusev basalts also have magnesium-chromium ratios that are similar to olivine-phyric shergottites (Figure 13b). In this case, chromium occurs

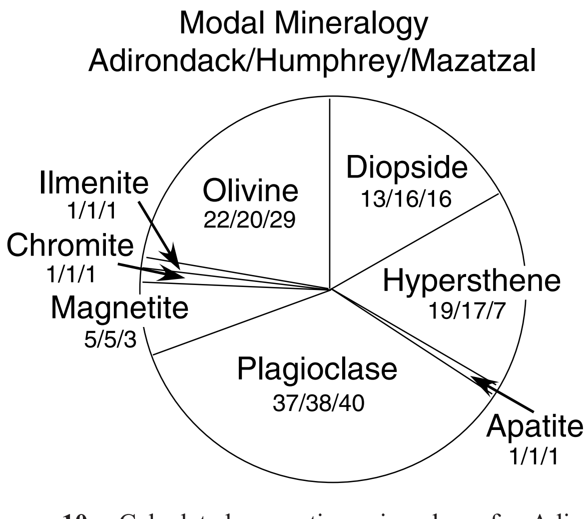

Figure 10. Calculated normative mineralogy for Adirondack, Humphrey, and Mazatzal (Table 1). Mineral abundances (wt%) are given, in order, for each of the analyzed rocks.