Clay minerals are ubiquitous on Earth, form in the presence of liquid water and ultimately have important implications for life on Earth and other terrestrial planets. Recent studies of the sediments on Mars have detected Fe- and Mg-rich smectites from orbit via the near infrared spectrometers OMEGA and CRISM and \textit{in situ} by powder x-ray diffraction from the Mars Science Laboratory rover Curiosity at Gale Crater. For quantitative analysis, X-ray diffraction is the preferred method of mineral identification as it is fast, non-destructive, and only requires small amounts of sample material. However, clay mineral identification and semi-quantitative analyses can be difficult in mixed samples due to the complex nature of clay mineral structures and the presence of poorly crystalline clays. This paper outlines the nomenclature of clay mineral groups and describes their crystal structures. Among the groups reviewed are the chlorite, illite, kaolinite, smectite, and sepiolite-palygorskite groups. Sample preparation and analyses by smear mount, glycolation (for the identification of swelling clays) and heat treatments (to observe changes in d-spacings) are described. Data collection requirements and data treatment for optimal analyses are summarized. Advantages and limitations of the Rietveld method and reference intensity ratio method (RIR) are reviewed. The effect of Cu vs Co radiation on the quality of data and the ability to resolve Fe-rich features is illustrated. Furthermore, the data presented in this study was collected with the Bragg-Brentano\textsuperscript{HD} optic (BBHD), the new standard in high-speed, high-quality powder diffraction data. The data illustrates the improved intensities, optimized low angle performance, improved detection limits and featureless background profile of the BBHD optic allowing resolution of the 060 reflections for clay mineral identification in oriented smear mounts.