Light element data are required for robust and accurate lithogeochemical interpretations and are important components in the study of hydrothermal alteration and mineralization processes. In this contribution we review the latest available portable energy dispersive X-Ray Fluorescence (pXRF) technologies exclusively in the context of light element analysis, with focus on the acquisition of data for Na, Mg, Al and Si. We discuss pXRF hardware design limitations, quantify variables that attenuate X-ray energies through numerical modelling, including common pXRF configurations, and empirically investigate modern pXRF technologies used to mitigate X-ray attenuation and improve light element analysis. The void between the sample and detector is a key issue regarding the success of pXRF light element analysis. Dry-air (normal conditions), vacuum purge and helium flush systems are evaluated. Modelled data that use a nominal sample-detector void of 10 mm show that using helium in lieu of air improves X-ray transmission effectiveness from ≈2% to ≈99% for Na and ≈10% to ≈100% for Mg. Modelled detector window data show that using a graphene detector window in lieu of a traditional beryllium detector window improves X-ray transmission effectiveness for Na from ≈38% to ≈64% and ≈57% to ≈77% for Mg. Progressive X-ray transmission effectiveness equates to ≈63% Na and ≈76% Mg when using a helium-graphene pXRF configuration v. ≈1% for Na and ≈6% Mg when using a traditional in-air beryllium pXRF arrangement (i.e. without sample or X-ray entrance window media). Empirically determined improvements of the resolved signal are more modest than those of modelled X-ray transmission effectiveness data. Instrument noise, spectral overlaps and random counting errors are unavoidable and inherent with the limitations of modern detector technologies. However, the employment of helium with graphene detector window technology allows very precise data to be obtained at significantly shorter scan times (i.e. 20 s, instead of the traditional 60–180 s, i.e. 3–9 times faster): a scan time of 20 s can achieve a precision of ≈18% @ ≈0.4% Na and ≈8% @ ≈0.3% Mg for elemental interference-free samples. Precision will improve with increasing analyte concentration.