Graphitic layer encapsulated iron based nanoparticles (G@FeNPs) have recently been disclosed as an interesting type of highly active electrocatalysts for the oxygen reduction reaction (ORR). However, the complex composition of the metal-containing components and their contributions in catalysis remain unclear. As a representative catalyst of the unique encapsulated structure, a series of G@FeNPs catalysts were prepared by a high-pressure pyrolytic process with uniform and essentially identical morphologies but varied compositions. The catalysts exhibited a high onset potential of 0.85 V at 0.1 mA cm\(^{-2}\) in acidic media. By \(^{57}\)Fe-Mössbauer spectroscopy the iron containing components were identified including \(\alpha-\text{Fe}, \gamma-\text{Fe}, \gamma-\text{Fe}_2\text{O}_3\), and \(\text{Fe}_3\text{C}\) as well as a minor doublet component due to \(\text{Fe}^{3+}\) in high spin and/or \(\text{Fe}^{2+}\) in low spin state. The ORR activities are evaluated in terms of the mass specific kinetic current density found to be positively correlated with the \(\text{Fe}_3\text{C}\) content in the range of study, indicating involvement of the encapsulated nanoparticles in the ORR catalysis. The recognition of the Fe compositions and active sites provides new insights to the confined Fe-based ORR electrocatalysts and therefore options for further development of non-precious metal materials.