Compressed sensing (CS) is a fast and efficient way to obtain compact signal representations. Oftentimes, one wishes to extract some information from the available compressed signal. Since CS signal recovery is typically expensive from a computational point of view, it is inconvenient to first recover the signal and then extract the information. A much more effective approach consists in estimating the information directly from the signal's linear measurements. In this paper, we propose a novel framework for compressive estimation of autoregressive (AR) process parameters based on ad-hoc sensing matrix construction. More in detail, we introduce a compressive least square estimator for AR(p) parameters and a specific AR(1) compressive Bayesian estimator. We exploit the proposed techniques to address two important practical problems. The first is compressive covariance estimation for Toeplitz structured covariance matrices where we tackle the problem with a novel parametric approach based on the estimated AR parameters. The second is a block-based compressive imaging system, where we introduce an algorithm that adaptively calculates the number of measurements to be acquired for each block from a set of initial measurements based on its degree of compressibility. We show that the proposed techniques outperform the state-of-the-art methods for these two problems.