In this thesis we focuse on one-dimensional diffusion in a random potential given by the general Markov dichotomous process. It was shown in [5] that this problem is closely related to the study of the stochastic Riccati equation. Using Kolmogorov forward equation we have a solution in the case of a semi-infinite interval. In order to overcome the restriction of a semi-infinite interval we present an approach to solution based on the method of Carleman embedding. We give an expression for the moments in the Laplace domain in terms of an infinite-dimensional matrix element and we try to evaluate it in the limit of infinite time and semi-infinite interval. However we find a discrepancy between our result, numerical simulation and different theoretical approach to the same problem. We also develop Monte Carlo simulations of the Riccati equations and we compare them to analytical results.