Energy landscape of the reactions governing the Na + deeply occluded state of the Na +/K +-ATPase in the giant axon of the Humboldt squid

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The Na +/K + pump is a nearly ubiquitous membrane protein in animal cells that uses the free energy of ATP hydrolysis to alternatively export 3Na + from the cell and import 2K + per cycle. This exchange of ions produces a steady-state outwardly directed current, which is proportional in magnitude to the turnover rate. Under certain ionic conditions, a sudden voltage jump generates temporally distinct transient currents mediated by the Na +/K + pump that represent the kinetics of extracellular Na + binding/release and Na + occlusion/deocclusion transitions. For many years, these events have escaped a proper thermodynamic treatment due to the relatively small electrical signal. Here, taking the advantages offered by the large diameter of the axons from the squid Dosidicus gigas, we have been able to separate the kinetic components of the transient currents in an extended temperature range and thus characterize the energetic landscape of the pump cycle and those transitions associated wit