Measurement of D/H in comet 8P/Tuttle: On the Origin of Earth's Water. G. L. Villanueva[1], M. J. Mumma[1], B. P. Bonev[1], M. A. DiSanti[1], E. L. Gibb[2], H. Boehnhardt[3] and M. Lippi[3], [1]NASA – Goddard Space Flight Center MS 693, Greenbelt, MD, 20771, [2]University of Missouri, St. Louis, [3]Max-Planck Institute for Solar System Research, Germany.

We present an extremely sensitive search for HDO in comet 8P/Tuttle as measured in January 2008 with the new high-resolution infrared spectrometer at VLT, CRIRES. The deuterium enrichment of cometary water is one of the most important cosmogonic indicators in comets. The ratio $(D/H)_{H2O}$ preserves information about the conditions under which comet material formed, and tests the possible contribution of comets in delivering water for Earth's oceans.

Because of our planet's heliocentric position and its history of violent impacts, especially the one that induced formation of the Moon, it is currently speculated that Earth was extremely dry 4.4 billion years ago and comets might have later delivered the current water reservoir.

However, the only three measurements of D/H in comets (Halley[1], Hyakutake[2] and Hale-Bopp[3]) point towards a different direction. All show a similar enrichment of deuterium of ~ 2 times the value in standard mean ocean water (SMOW). This has often been used to argue against comets playing a major role in exogenous delivery of water and prebiotic organics to early Earth. Such enrichment is characteristic of ion-molecule chemistry below 30 K, and could be the signature of interstellar ice, or perhaps of X-ray driven ion-molecule chemistry in the nebula. This and other indicators also suggest these three comets originated beyond 30 AU.

Do we expect all comets to have the same D/H? Is the D/H measured from volatile water also representative of the D/H in the nuclear ices? Has the D/H on Earth changed over geological time and is it no longer representative of its primitive endowment? These important questions can be addressed only by measuring $(D/H)_{H2O}$ for large number of comets of different types and families. Associated modeling of atmospheric escape and fractionation in Earth's core is also needed.

Historically, dynamical properties have been used to infer the formation region of comets, and herewith their primordial chemical properties (for example Kuiper belt comets were believed to have formed "*in situ*", i.e. in the outer protoplanetary disk). However, now a new paradigm is emerging. The recent "Nice" model [4,5] predicts that the two main comet reservoirs (Oort cloud and Kuiper disk) could have been fed by bodies formed in the outer proto-planetary disk (beyond $R_h \sim 17$ AU) and also in the giant-planets' feeding zones (5 - 14 AU). This is consistent with the diversity in chemical composition observed in comets of the same dynamical class [Mumma et al., this conference]. The measurements of chemical composition and isotopic ratios go hand-in-hand when evaluating formation region and possible delivery of water to Earth.

8P/Tuttle is a particularly interesting example. It is a periodic comet of the "Halley" type family, a dynamical class hypothesized to derive from the inner Oort cloud [6], or from the scattered Kuiper disk [7]. Recent observations by our team [8, 9] indicate a very distinctive chemistry [Lippi et al., this conference]. Is the D/H of 8P/Tuttle consistent with observations of other comets, or is it as distinctive as its chemical composition? We will present spectra sampling 32 lines of HDO and multiple lines of H_2O, both observations taken in subsequent days using the same instrument. Together these present a sensitive measure of D/H in this comet.

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