

In lunar samples, silica polymorphs most commonly occur as accessory minerals in basalts. Of the 253 basalt samples listed in the Lunar Sample Compendium (Meyer, 2012), 146 contain at least trace concentrations of a silica phase (Appendix 5 Table A1). Twenty silica-containing high-K and low-K ilmenite basalts have been identified from Apollo 11 (Dence et al., 1970; James and Jackson, 1970; Kushiro and Nakamura, 1970; Sippel and Spencer, 1970; Beaty and Albee, 1978). The Apollo 11 silica-containing basalts were all reported to contain cristobalite. James and Jackson (1970) noted that the Apollo 11 basalts with coarser grains contain tridymite and cristobalite, but the more fine-grained Apollo 11 basalts contain only cristobalite. Kushiro and Nakamura (1970) and Beaty and Albee (1978) assumed that all silica present in the samples that they studied is cristobalite.

From the Apollo 12 basalts in the Lunar Sample Compendium (Meyer, 2013), thirty-one contain silica—twelve pigeonite basalts, eleven ilmenite basalts, seven olivine basalts, and one feldspathic basalt (Appleman et al., 1971; Champness et al., 1971; Dollase et al., 1971; Klein et al., 1971; Sippel, 1971; Taylor et al., 1971; Bunch et al., 1972; Dungan and Brown, 1977; Baldrige et al., 1979; Neal et al., 1994). Nine Apollo 12 basalts are reported to contain an unidentified polymorph of silica (Baldrige et al., 1979; Neal et al., 1994). Olivine basalt 12018 and pigeonite basalt 12065 are reported to contain both cristobalite and quartz (Sippel, 1971). The silica polymorphs identified in Apollo 12 basalts, excluding 12018 and 12065, are cristobalite and tridymite, which are reported to occur together in some samples (e.g., ilmenite basalt 12064; Klein et al., 1971). The only commentary on the texture of silica occurring in Apollo 12 basalts was made by Neal et al. (1994) who identified tridymite with a “crinkled texture” in pigeonite basalt 12019; ilmenite basalts 12064, 12061, and 12062; and olivine basalt 12072.

Silica minerals have been identified in two Apollo 14 basalts listed in the Lunar Sample Compendium (Meyer, 2012). Sample 14053 is a tridymite-bearing (Taylor et al., 2004), high-Al basalt. Olivine basalt 14072 is reported to contain both “mosaic cristobalite” and tridymite (Longhi et al., 1972).

The Lunar Sample Compendium (Meyer, 2012) lists forty-one Apollo 15 basalts that contain a silica mineral. A silica phase is reported but not identified in “gabbroic” basalt 15065 (Longhi et al., 1972) and pigeonite basalt 15476 (Papike et al., 1976). Twenty-nine samples are olivine-normative basalts all of which are reported to contain cristobalite (Dowty et al., 1973; Rhodes and Hubbard, 1973; Nord et al., 1973; Ryder, 1985; Shervais et al., 1990). There are seven silica-bearing Apollo 15 pigeonite basalts—four reportedly contain cristobalite (15058, 15076; Rhodes and Hubbard, 1973; 15118, 15388; Dowty et al., 1973), sample 15475 contains tridymite (Rhodes and Hubbard, 1973), and samples 15075 (Taylor and Misra, 1975) and 15085 (Brown et al., 1972) contain cristobalite and tridymite. Olivine-phyric basalt 15105 contains cristobalite (Dowty et al., 1973), “pyroxene basalt” 15116 contains cristobalite and tridymite (Dowty et al., 1973), and KREEP basalt 15382 contains cristobalite (Dowty et al., 1976). Sample 15382 is the only KREEP basalt with reported silica in the Lunar Sample Compendium (Meyer, 2012). Warren et al. (1983a) reported silica in KREEP basalt fragments 15007,290 and 15007,293.

Of the Apollo 16 samples described in the Lunar Sample Compendium (Meyer, 2012), only “highland basalt” 65795 is reported to contain a silica mineral (Dowty et al., 1974), but the silica polymorph has not been identified.

Fifty-five silica-bearing Apollo 17 ilmenite basalt samples are listed in the Lunar Sample Compendium (Meyer, 2012). Thirty-seven of these samples contain silica (Dymek et al., 1975;

Warner et al., 1978; Neal and Taylor, 1993) for which the polymorph has not been reported. The other eighteen samples are reported to contain cristobalite (Brown et al., 1975; Taylor et al., 1992). Dymek et al. (1975) identified tridymite and cristobalite in sample 75055.

There are significantly fewer intrusive rocks than extrusive (basalt) in the Apollo sample suite. Only fifty-six intrusive igneous samples are identified in the Lunar Sample Compendium (Meyer, 2012). Of those intrusive igneous samples, only ferroan anorthosite 15415 (Stewart et al., 1972) and cataclastic norite 77215 (Chao et al., 1976) contain silica of unknown polymorph. However, several samples of quartz monzodiorite (or quartz monzogabbro, Jolliff et al., 1999), a silica-bearing evolved lithology, have been identified as fragments in the lunar soil or as clasts in breccias (Ryder, 1976; Taylor et al., 1980; Lindstrom et al., 1988; Jolliff, 1991; Jolliff et al., 1991; Marvin et al., 1991; Ryder and Martinez, 1991). Jolliff et al., 1999 identified quartz (some of which they describe as “relict cristobalite”) and amorphous silica in quartz monzogabbro 14161,7373. Additionally, as compiled by Warren (1993), silica was reported in alkali norite 14304c86 (Goodrich et al., 1986), monzonorite 14316c12 (Warren et al., 1981), alkali norite 15405c170 (Marvin et al., 1991), quartz gabbro 15434,12 (Ryder and Martinez, 1991), granular Fe-norites 15459c279,292 (Lindstrom et al., 1988), feldspathic basalt 67015c310 (Marvin et al., 1987), sodic ferrogabbro 67915c163 (Marti et al., 1983), alkali gabbro-norite clasts in breccia 67975 (James et al., 1987), pyroxene anorthosites 73255c27,80 (James and McGee, 1979).

Appendix 5 Table A1. Silica polymorphs in Apollo basalts.

	Apollo 11	Apollo 12	Apollo 14	Apollo 15	Apollo 16	Apollo 17
Quartz	n.r.	1	n.r.	n.r.	n.r.	n.r.
Tridymite	2	9	2	4	n.r.	1
Cristobalite	20	12	1	38	n.r.	18
Unidentified	n.r.	9	n.r.	2	1	37
Total Basalt Samples	20	31	12	79	9	80

We list the number of basalt samples (Meyer, 2012), and the silica polymorphs that the basalt samples contain, at each Apollo site. “n.r.” means “not reported.”