

# **The Laramide Caborca Orogenic Gold Belt of Northwestern Sonora, Mexico: White Mica $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology from Gold-Rich Quartz Veins**

Open-File Report 2016–1008



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By Aldo Izaguirre, Michael J. Kunk, Alexander Iriondo, Ryan McAleer, Juan Antonio Caballero-Martínez, and Enrique Espinosa-Arámburu

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## Conversion Factors

| Multiply       | By     | To obtain |
|----------------|--------|-----------|
|                | Length |           |
| kilometer (km) | 0.6214 | mile (mi) |

Temperature in degrees Celsius ( $^{\circ}\text{C}$ ) may be converted to degrees Fahrenheit ( $^{\circ}\text{F}$ ) as follows:  
 $^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$

# The Laramide Caborca Orogenic Gold Belt of Northwestern Sonora, Mexico: White Mica $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology from Gold-Rich Quartz Veins

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## 1. Introduction

This report contains reduced  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronological data from hydrothermal white mica (63 samples) separated from orogenic quartz gold-rich veins in the Laramide Caborca orogenic gold belt (COGB) of northwestern Sonora, Mexico (fig. 1). The main objective of this report is to present the sample locations,  $^{40}\text{Ar}/^{39}\text{Ar}$  experimental methodology, and  $^{40}\text{Ar}/^{39}\text{Ar}$  isotopic data (tables 1–4). We also include age spectra and inverse-isotope correlation diagrams for all white mica samples (figs. 3–5). The age spectra are separated into three groups based on the type of age used for geologic interpretation, including (1) plateau ages, (2) isochron ages, and (3) average or single-step heating ages. These age spectra are interpreted to represent the time of mineralization for each sample locality, and together, all the ages help to establish the age of mineralization for the entire COGB (fig. 2). Another objective of this Open-File Report (OFR) is to organize the data in a systemic way so that they can be integrated into future scientific publications.

The COGB is approximately 600 kilometers (km) long and 60 to 80 km wide, trends northwest, and extends from west-central Sonora to southern Arizona and California (fig. 1). The COGB contains mineralized gold-rich quartz veins that contain free gold associated with white mica “sericite” and carbonate minerals (calcite and ankerite) plus sulfides such as pyrite and galena (Izaguirre and others, 2012).

Limited geochronologic studies (K-Ar, Ar-Ar (white mica), and Re-Os (magnetite)) exist for parts of the COGB, and previous work was concentrated in mining districts (Pérez-Segura, 1993; Pérez-Segura and others, 1996; Araux-Sánchez, 2000; Iriondo and Atkinson, 2000; Iriondo, 2001; Poulsen and others, 2008; Quintanar-Ruiz, 2008). These scattered studies recorded mineralization ages of approximately 70 to 40 Ma (mega-annum, or million years ago). Therefore, some workers proposed that the orogenic gold mineralization in the region occurred during a single pulse that was associated with the Laramide Orogeny that took place during Cretaceous to early Eocene in the western margin of North America (Damon and others, 1964; Coney, 1976; Dickinson and others, 1988). However, the geochronologic dataset was quite limited, making any regional interpretations tenuous. Accordingly, one of the objectives of this geochronology study was to get a better representative sampling of the COGB in order to obtain a more complete record of the mineralization history. The 63 samples presented in this work are broadly distributed throughout the area of the COGB (fig. 1) and allow us to better test the hypothesis that mineralization occurred in a single pulse.

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## 2. Methods

### 2.1. Sample Preparation

All of the quartz vein samples were crushed, ground, and sized using 250-, 180-, and 150-micrometer ( $\mu\text{m}$ ) sieves. White mica separations were performed using a magnetic separation instrument (Frantz<sup>TM</sup>), paper shaking, and hand picking with a goal of getting greater than 99 percent purity on the white mica. The resulting separates were washed three times in acetone, alcohol, and deionized water in an ultrasonic cleaner (Branson<sup>TM</sup>) to remove dust and other impurities, and then re-sieved using 250- and 180- $\mu\text{m}$  sieve sizes.

### 2.2. Packing and Irradiation Method

The samples were irradiated in five separate irradiation packages (DD60, KD12, KD52, KD53, and KD55). Two copper packets were loaded for each white mica sample, with weights of approximately 1 milligram (mg) and 20 mg, respectively. The packets were sealed under vacuum in fused silica tubes and irradiated in the central thimble facility at the Training Reactor Isotopes General Atomics (TRIGA) reactor at the U.S. Geological Survey in Denver, Colorado. The monitor mineral used in all the irradiation packages was hornblende (sample MMhb-1) with an age of  $519.4 \pm 2.5$  Ma (Alexander and others, 1978; Dalrymple and others, 1981). The type of container, and the geometry of samples and standards are similar to those described by Sneek and others (1988).

### 2.3. Sample Analysis

White mica samples were analyzed in the U.S. Geological Survey Argon Thermochronology Laboratory in Reston, Virginia. The large white mica samples (approximately 20 mg) were analyzed in a VG Isotopes, Ltd. model 1200 mass spectrometer fitted with an electron multiplier using the  $^{40}\text{Ar}/^{39}\text{Ar}$  step-heating method. All samples were heated for 10 minutes per step (11–20 steps) in a small-volume, molybdenum-lined, low-blank tantalum resistance furnace similar to that described by Staudacher and others (1978). The temperature was monitored by a W5Re-W26Re thermocouple and controlled by a proportional, programmable controller. The furnace and the rear manifold were pumped between steps with a turbo molecular pump. Two isolated ion pumps evacuated the front manifold and the mass spectrometer flight-tube between each incremental step. Prior to analysis in the mass spectrometer, the gas was purified in the rear manifold by a SAES ST707 Zr-V-Fe (zirconium-vanadium-iron) getter operated at room temperature and a hot Re (rhenium) filament. Gas was equilibrated with the front manifold, then isolated and cleaned in the front manifold with a SAES ST101 Al-Zr (aluminum-zirconium) getter operated at 400°C and a Ti (titanium) getter operated at 350°C.

An activated charcoal finger submerged in a thermally equilibrated mixture of dry ice and acetone in the front manifold was used to remove gasses with a molecular weight greater than 60 or 80 (primarily other noble gasses) prior to the expansion of the Ar (argon) dominated gas into the mass spectrometer. The gas was further purified in the mass spectrometer by a second SAES ST101 getter operated at room temperature. Ar isotopes with atomic weights of 40 through 36 and  $\text{CO}_2$  (atomic weight of 44) were analyzed as a function of time in five or six analytical cycles.  $^{40}\text{Ar}$ ,  $^{39}\text{Ar}$ ,  $^{38}\text{Ar}$ , and  $^{37}\text{Ar}$  peaks and their baselines were measured for five, 1.28-second integrations in each of the five cycles.  $^{36}\text{Ar}$  and its baselines were measured for twenty, 1.28-second integrations in each cycle. After the analysis, the mass spectrometer was evacuated with an isolated ion pump. All phases of the sample heating, cleanup, equilibration, and analysis were performed under computer automation.

Smaller white mica samples (weights of approximately 1 mg) were analyzed using a MAP-216 mass spectrometer fitted with an electron multiplier using the  $^{40}\text{Ar}/^{39}\text{Ar}$  step-heating dating method. Heating for 10 minutes per step followed a schedule of 11 to 20 steps. The heating schedules were designed such that the percentage of  $^{39}\text{Ar}$  released per step was limited to less than 20 percent of the total released for most samples. The samples were heated in the same manner and in the same type of furnace as was described earlier. The furnace and the rear and front manifolds were pumped between steps with a turbo molecular pump. An isolated ion pump was used to pump the mass spectrometer. Prior to the mass spectrometer analysis, the gas was purified in the manifold by two SAES ST101 Al-Zr getters, one operated at room temperature and a second one using a hot Re filament at 400°C. The Ar-rich gas was further purified by a third SAES ST101 getter operated at room temperature in the flight tube of the mass spectrometer. Ar isotopes with atomic weights of 40 through 36 were analyzed as a function of time in six analytical cycles. Baselines were measured for  $^{39}\text{Ar}$  and  $^{36}\text{Ar}$ . The  $^{36}\text{Ar}$  baselines were subtracted from the  $^{40}\text{Ar}$ ,  $^{38}\text{Ar}$ ,  $^{37}\text{Ar}$ , and  $^{36}\text{Ar}$  peaks. The  $^{39}\text{Ar}$  baseline was subtracted from the  $^{39}\text{Ar}$  peak to reduce the influence of the tail of the  $^{40}\text{Ar}$  peak.

## 2.4. Isotopic Data Reduction

All the isotopic data produced on the VG-1200 spectrometer were reduced using an updated version of the computer program ArAr\* (Haugerud and Kunk, 1988). Isotopic data from the MAP-216 spectrometer was reduced using the computer program Mass Spec (Deino, 2001). We used the decay constants recommended by Steiger and Jäger (1977). The isotopic measurements made in the five- or six-cycle analysis were regressed to time zero (2/3 of the inlet time) using standard linear regression techniques. These regressed peak values, and associated analytical uncertainties, were used in data reduction. For the VG-1200 and the MAP-216, full system blanks were measured prior to the suite of analyses made on each sample and then subtracted from the analytical results. Error estimates of the blanks were quadratically combined with the analytical errors.

Corrections for interfering reactor-produced Ar isotopes from Ca (calcium), K (potassium), and Cl (chlorine) in the sample were made using the production ratios given in Dalrymple and others (1981) and Roddick (1983). Errors in calculated ages or ratios include the measurement uncertainty in the analysis, decay factor uncertainties, uncertainties in measured atmospheric  $^{40}\text{Ar}/^{36}\text{Ar}$  ratios, the irradiation parameter J, the production ratios of the various reactor induced Ar producing reactions, the initial  $^{38}\text{Ar}/^{36}\text{Ar}$  ratio, and the age of the monitor mineral (Haugerud and Kunk, 1988).

The data in tables 2, 3, and 4 include individual step ages and total gas ages. Total gas ages represent the age calculated from the addition of all the measured Ar peaks for all steps in a single sample. The total gas ages are roughly equivalent to conventional K/Ar ages; however, no analytical precision is calculated for these total gas ages.

## 3. Results of $^{40}\text{Ar}/^{39}\text{Ar}$ Data

White mica  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronological results of 63 samples presented in this report (tables 1–4 and figs. 3–5) are subdivided into the following three age groups: plateau ages (group 1), isochron ages (group 2), and average or single-step ages (group 3). The reported ages are plotted in figure 1, and improve our knowledge of the timing of hydrothermal gold-rich quartz vein formation in the COGB.

### 3.1. Group 1 Plateau Ages

Group 1 is made up of 21 samples (tables 1 and 2; fig. 3) of coarse flakes of white mica separated to an optical purity of greater than 99 percent. The data from step-heating experiments on these samples meet the criteria for a plateau age defined by Fleck and others (1977) and modified by Haugerud and Kunk (1988). All of the white mica samples in this group released argon  $^{39}\text{Ar}_k$  in three steps or more (accounting for a minimum of 50 percent of the total released gas) at furnace temperatures between approximately 800 to 1250°C (sample Quitovac-5; fig. 3U). In addition, isochron ages calculated for these samples, shown in inverse isotope diagrams of  $^{36}\text{Ar}/^{40}\text{Ar}$  vs.  $^{39}\text{Ar}/^{40}\text{Ar}$  (sample Quitovac-5; fig. 3V), support within analytical error, the more precise plateau ages (summarized in table 1). Therefore, these white mica plateau ages that range from approximately 66 to 48 Ma are interpreted to be the best approximation for the age of hydrothermal activity that resulted in this group of gold-rich quartz veins.

### 3.2. Group 2 Isochron Ages

Group 2 is made up of 16 samples (tables 1 and 3; fig. 4). White mica from these samples includes both coarse flakes and fine-grained aggregates, separated to an optical purity of greater than 99 percent. The flat age spectra from step-heating experiments on these samples did not meet the statistical definition of a plateau (Fleck and others; 1977). For these slightly irregular age spectra (sample Trin-10; fig. 4AC), inverse isotope correlation diagrams of  $^{36}\text{Ar}/^{40}\text{Ar}$  vs.  $^{39}\text{Ar}/^{40}\text{Ar}$  were generated and isochron ages calculated. A regression (and the resulting age) is considered meaningful if it includes more than three contiguous heating steps that accounts for at least 50 percent of the total  $^{39}\text{Ar}_k$  released and has a MSWD (mean square weighted deviation) of  $\leq 2.5$ . The age range determined for this group of white micas is approximately 62 to 36 Ma, and interpreted as the age interval for hydrothermal mineralization along the COGB.

### 3.3. Group 3 Average or Single-Step Ages

Group 3 is made up of 26 samples of white mica (tables 1 and 4; fig. 5) that consist of mostly fine-grained aggregates of white mica. These samples were prepared to a variety of purity levels (in a few instances less than 99 percent purity). It is possible that many of the impurities in the white mica separates included quartz, plagioclase, K-feldspar, or even igneous or metamorphic white micas from the quartz vein host rocks. These impurities made the  $^{40}\text{Ar}/^{39}\text{Ar}$  data results more difficult to interpret.

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The data for group 3 white mica samples did not meet the statistical criteria for a plateau or isochron age. However, for a group of 15 of these samples we calculated average ages for a set of contiguous steps (selected steps provided in figure 5). The selected steps define a flat portion of each age (spectrum similar to a plateau), but failed to meet one or more of the requirements established by Fleck and others (1977). This behavior is well represented in white mica sample Pit-4 (fig. 5A1) where 6 steps, representing 87 percent of the total  $^{39}\text{Ar}_k$  released, were used to calculate the weighted-average age. The resulting weighted-average ages are very similar to the calculated total gas ages for the same samples. This group of 15 white micas yielded average ages in a range between approximately 65 to 39 Ma, consistent with the ages determined from groups 1 and 2.

For the remaining 11 samples from group 3 the age of a single-step was used as the preferred age (ages summarized in table 1). The resulting age spectra from these 11 samples are difficult to interpret meaningfully from the step heating results, but it is important to illustrate that not all the  $^{40}\text{Ar}/^{39}\text{Ar}$  data for these gold-rich quartz veins is considered “well behaved” or “ideal,” which would generally yield a flat spectrum. A good example of a “non-ideal” staircase age spectrum is shown in figure 5S (sample El Chanate) in which step C is selected as the assigned age of the sample. The single-step ages of the 11 samples are chosen by selecting the first heating step of the staircase age spectrum in which we observe a tendency of the spectrum to flatten out. The selected single-step age is interpreted as representing the maximum possible age for the formation of the white mica.

Group 3 average and single-step ages range from approximately 69 to 39 Ma. The resulting age spectrum data from group 3 are more complex than groups 1 and 2, however, the determined ages are consistent with the more reliable ages of groups 1 and 2.

### 3.4. Histogram and Cumulative Probability Diagram of Ages

In order to evaluate and interpret the resulting  $^{40}\text{Ar}/^{39}\text{Ar}$  data of the 63 white mica samples, we generated a histogram and a cumulative probability diagram (fig. 2) of all the determined ages. The diagram shows the age range as well as apparent ages of more abundant gold mineralization along the COGB. The Late Cretaceous to late Eocene age range (69 to 36 Ma) for the quartz veins represents a mineralization event that lasted for more than 30 million years. However, in the histogram a probability peak at approximately 61 Ma is interpreted as the climax of mineralization. The climax of mineralization at 61 Ma occurred within the main pulse of mineralization between approximately 63 to 56 Ma (age range of the majority of analyzed white mica samples; 35 white micas and approximately 56 percent of the total samples). After approximately 48 Ma, only 5 scattered ages of mineralization are identified in figure 2. The youngest age is 36 Ma and represents the youngest mineralization age determined for the gold veins along the COGB.

## 4. Conclusions

Organization of this large  $^{40}\text{Ar}/^{39}\text{Ar}$  dataset into three age groups has facilitated the interpretation of the timing of mineralization of gold-rich quartz veins in the COGB (table 1). The data presented in this report will serve as a data repository to facilitate the integration of the age data in future manuscripts for publication in scientific journals, where space restrictions are common.

We conclude that the ages between approximately 69 to 36 Ma (figs. 1 and 2), determined from the 63 white micas, represent the timing of orogenic gold mineralization in northwestern Sonora, Mexico, supporting previous interpretations that these gold-rich quartz veins are restricted to the Late Cretaceous to Eocene time. The vast majority of the sample ages (>56 percent) were determined to be between approximately 63 to 56 Ma, which we interpret as the climax of gold mineralization along the COGB. Moreover, the frequency of mineralization gradually decreased from approximately 56 to 48 Ma, followed by a final stage of vein formation that occurred between approximately 45 to 36 Ma. The end of mineralization most likely relates to the contemporaneous cessation of the Laramide orogeny along this portion of the North American Cordillera.

## 5. Acknowledgments

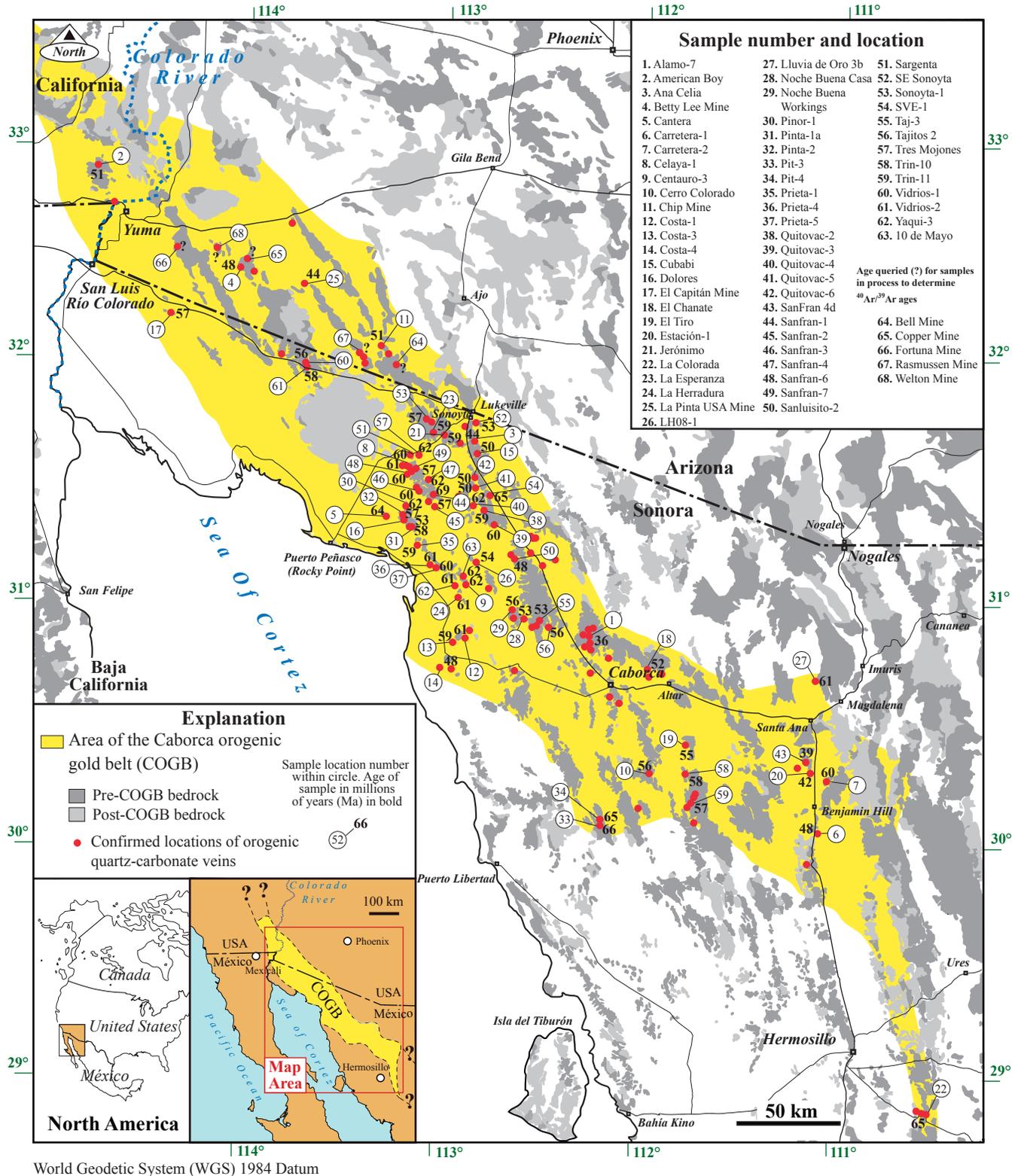
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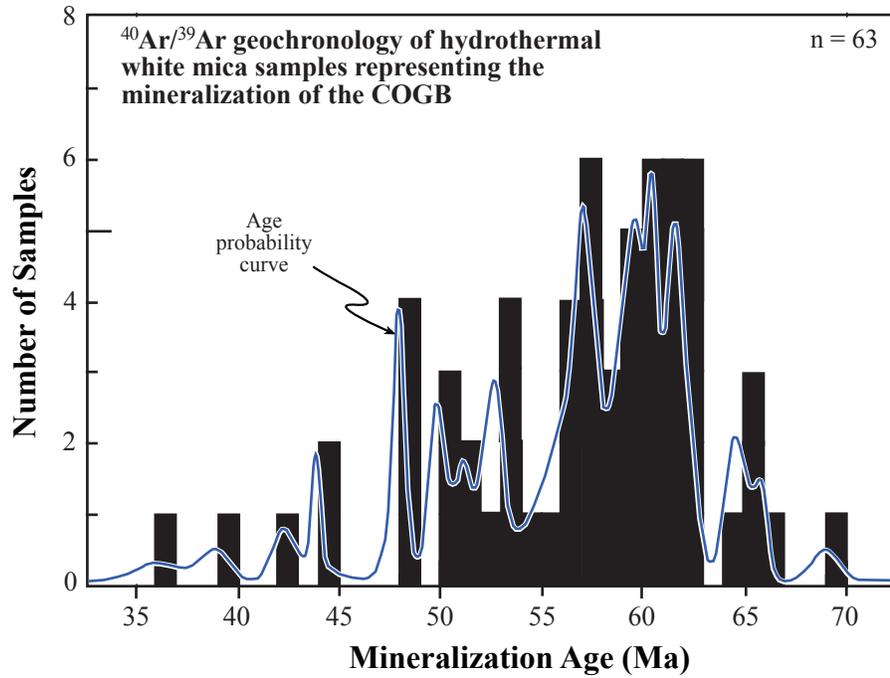
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## **6 The Caborca Orogenic Gold Belt of Sonora, Mexico: Mica $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology from Gold-Rich Veins**

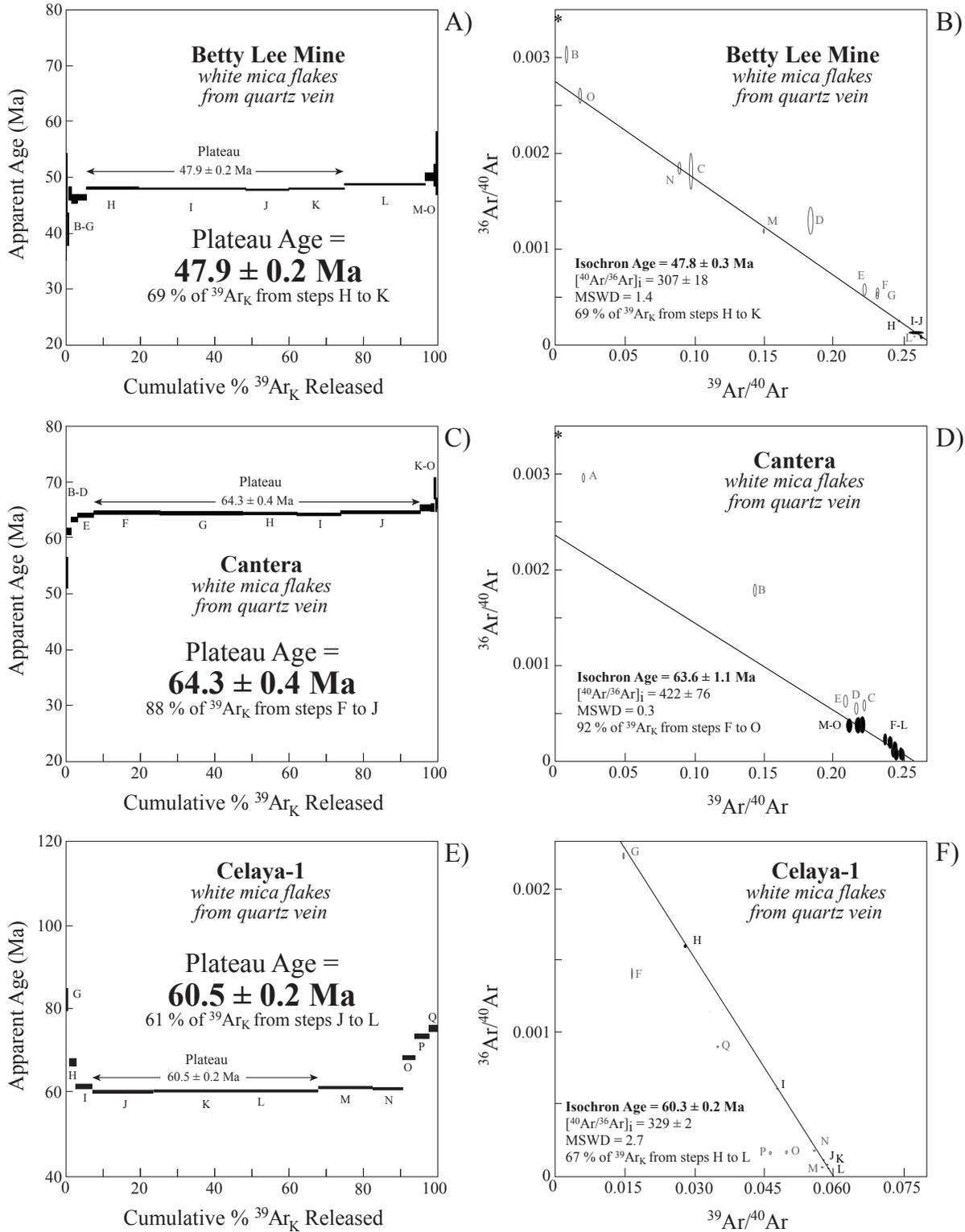
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**Figure 1.** Sample locations for dated white micas of gold-rich quartz veins. Numbers in bold represent  $^{40}\text{Ar}/^{39}\text{Ar}$  ages determined in this open-file report from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. Shades of gray represent pre-COGB mineralization (dark-gray) and post-COGB mineralization (light-gray) bedrock outcrops after Iriondo (2001).



**Figure 2.** Histogram and cumulative probability distribution diagram (blue line) of  $^{40}\text{Ar}/^{39}\text{Ar}$  ages determined from hydrothermal white mica samples of gold-rich quartz veins from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. Abbreviations: Ma, mega-annum; n, number of samples.



**Figure 3.** Age spectra (A, C, E) and inverse-isotope correlation diagrams (B, D, F) from group 1 of white mica samples of gold-rich quartz veins, with plateau ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio. Abbreviations: Ma, mega-annum; MSWD, mean square weighted deviation.

10 The Caborca Orogenic Gold Belt of Sonora, Mexico: Mica  $^{40}\text{Ar}/^{39}\text{Ar}$  Geochronology from Gold-Rich Veins

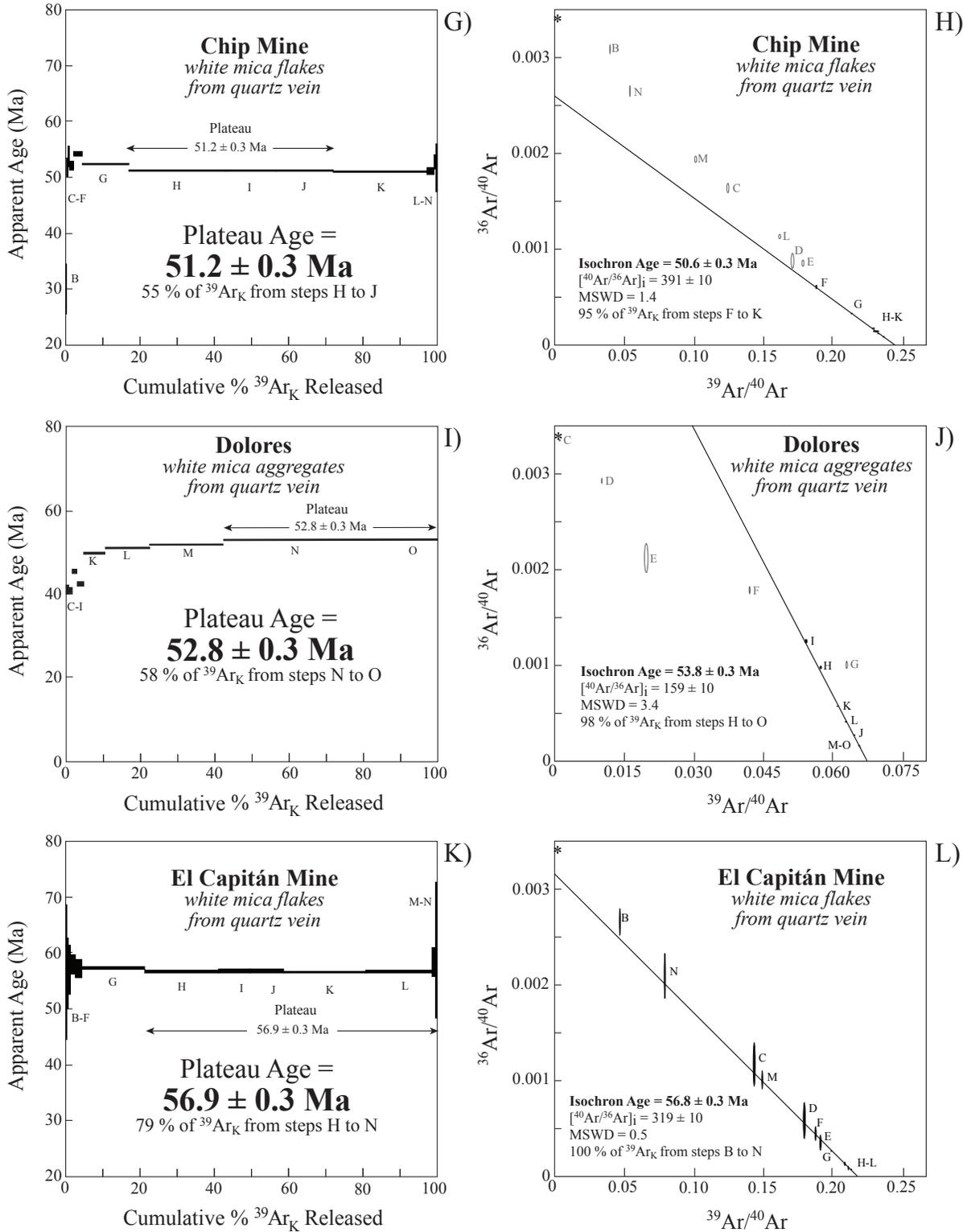
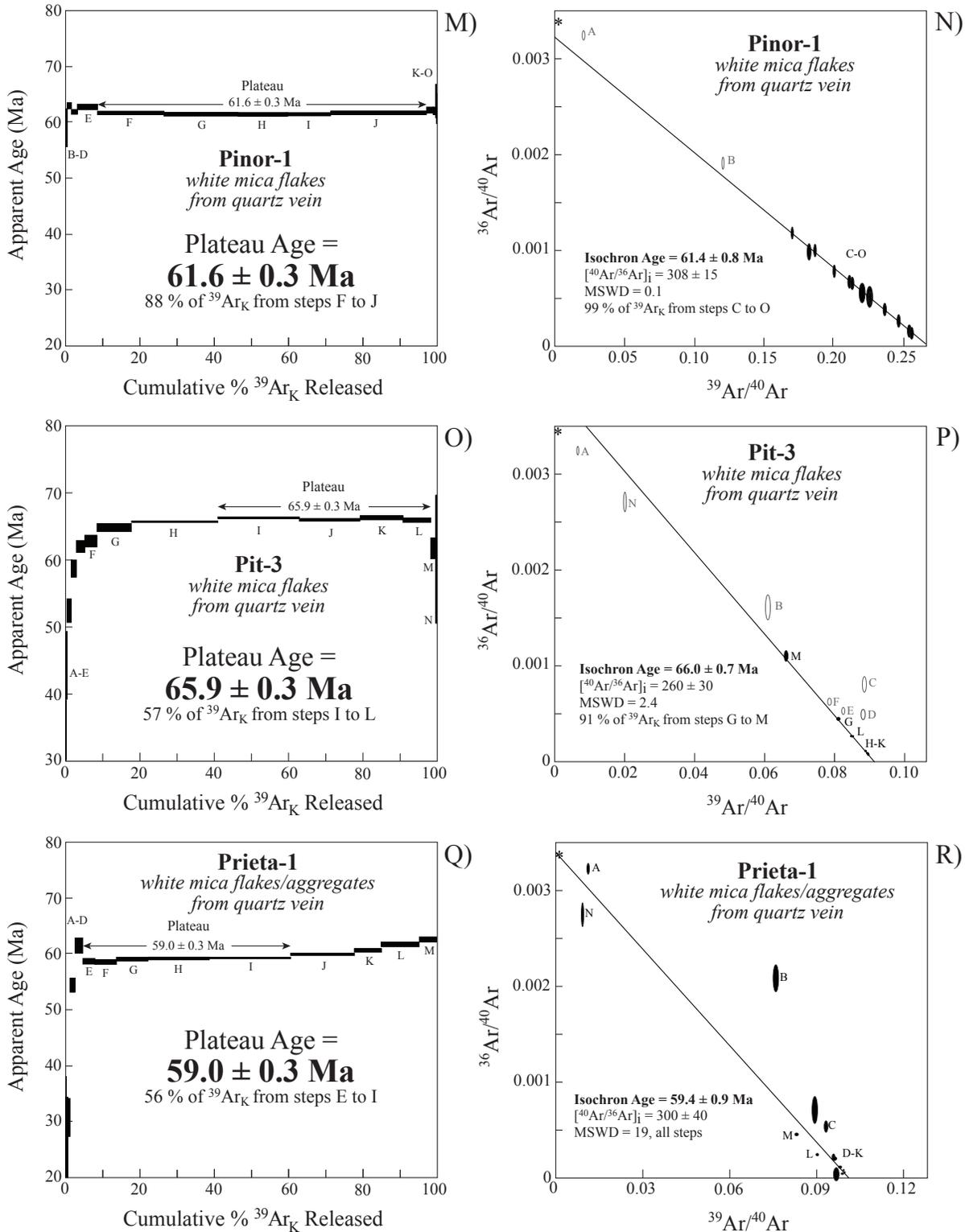


Figure 3—Continued. Age spectra (G, I, K) and inverse-isotope correlation diagrams (H, J, L) from group 1 of white mica samples of gold-rich quartz veins, with plateau ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 3—Continued.** Age spectra (M, O, Q) and inverse-isotope correlation diagrams (N, P, R) from group 1 of white mica samples of gold-rich quartz veins, with plateau ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

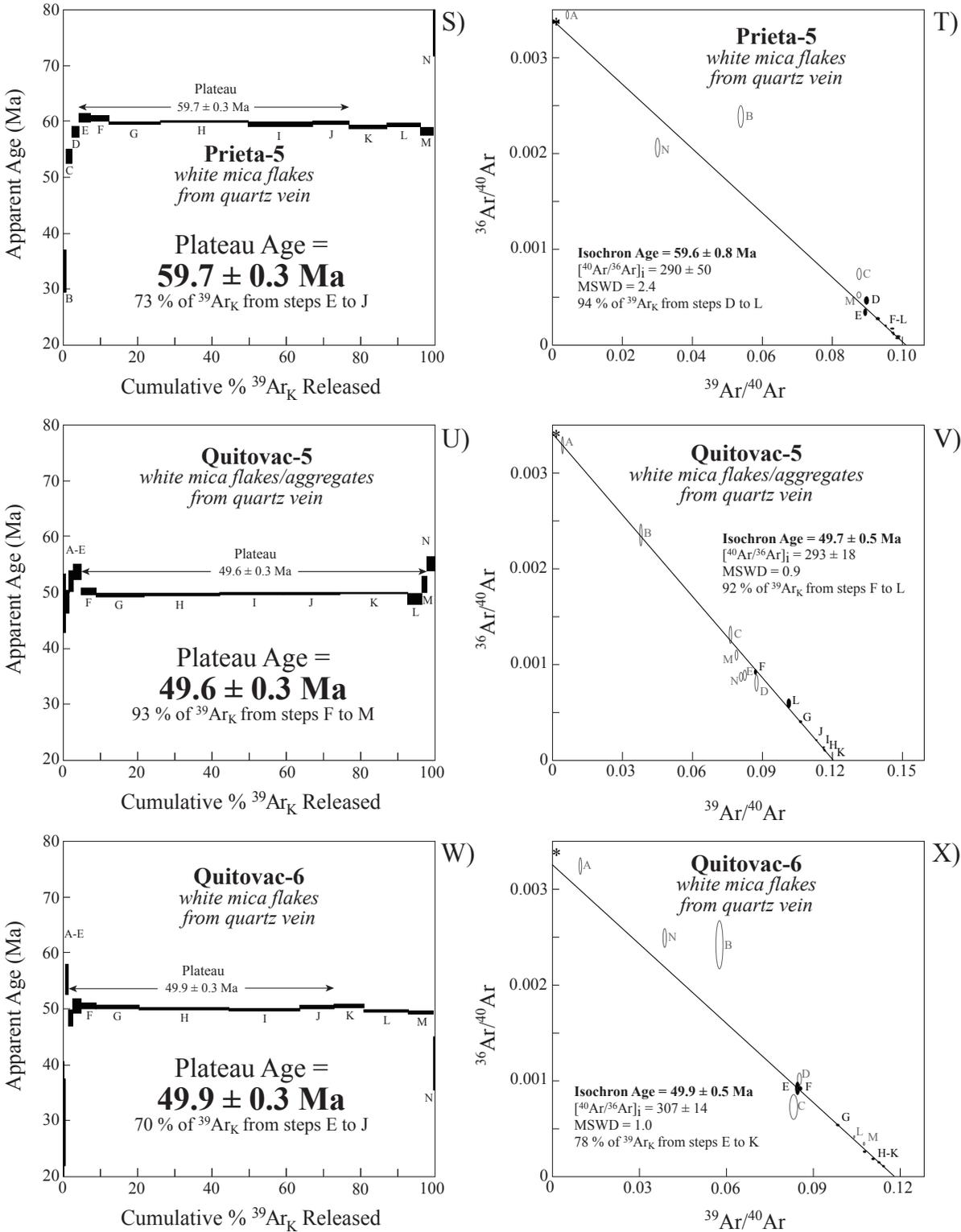
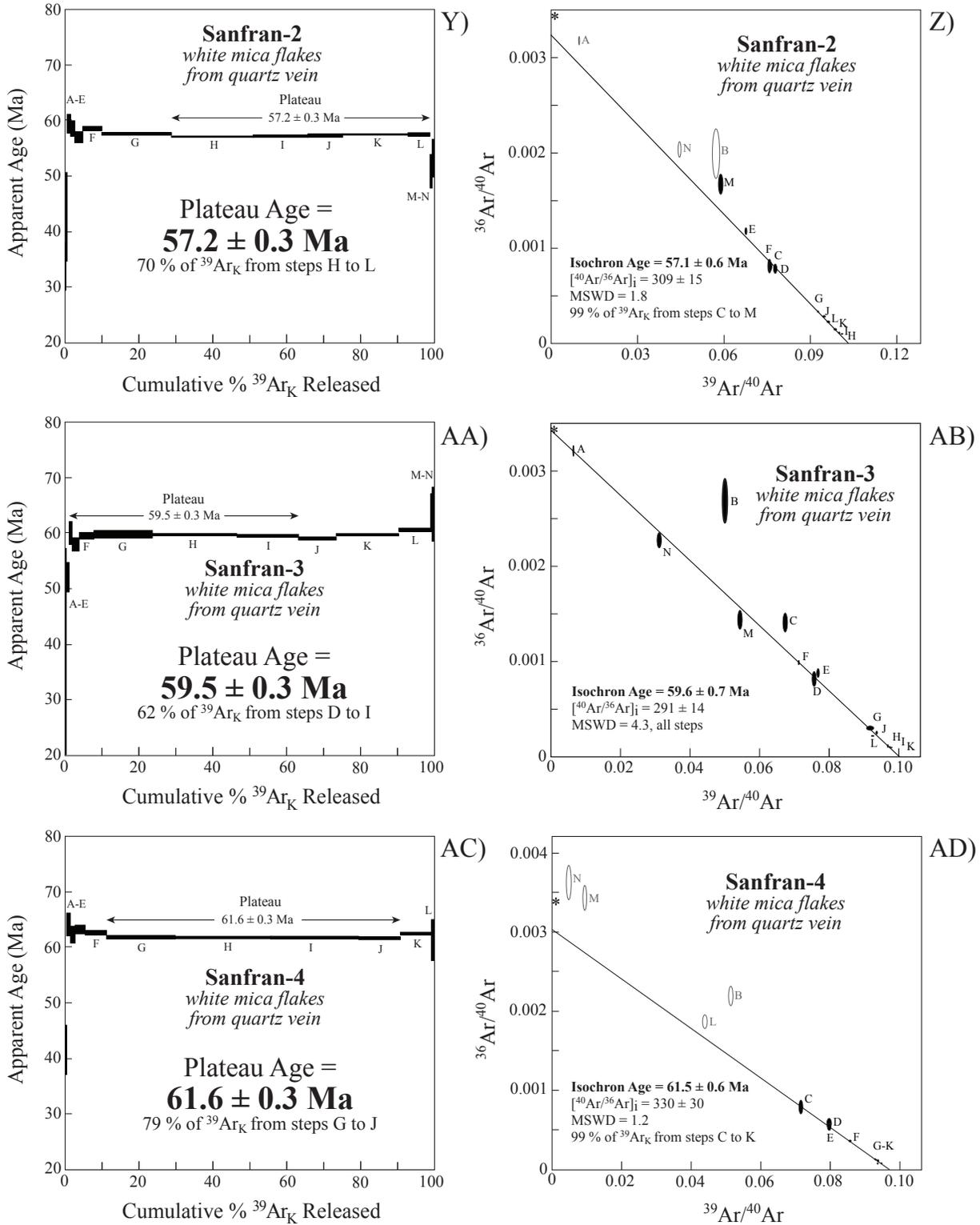


Figure 3—Continued. Age spectra (S, U, W) and inverse-isotope correlation diagrams (T, V, X) from group 1 of white mica samples of gold-rich quartz veins, with plateau ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 3—Continued.** Age spectra (Y, AA, AC) and inverse-isotope correlation diagrams (Z, AB, AD) from group 1 of white mica samples of gold-rich quartz veins, with plateau ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

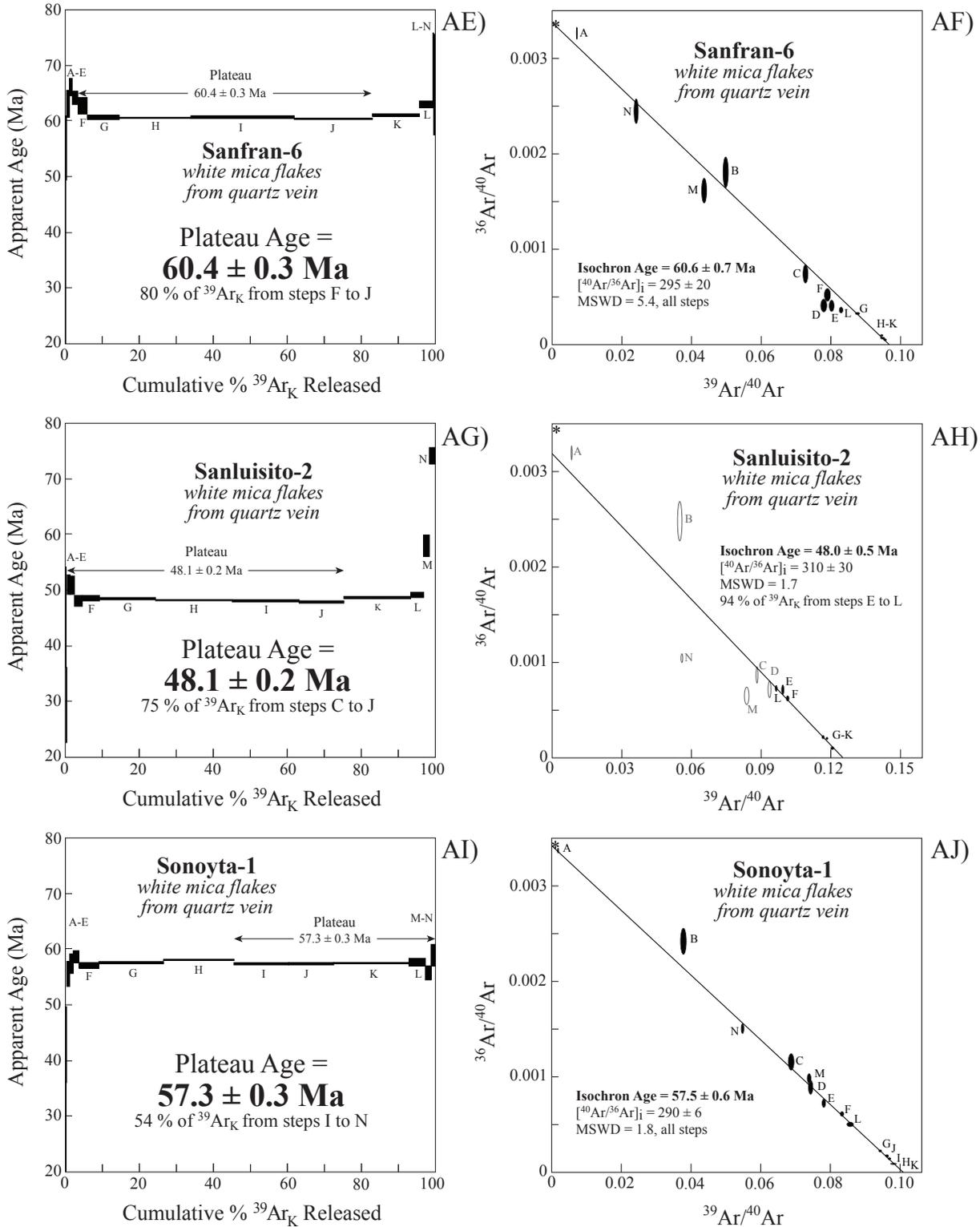
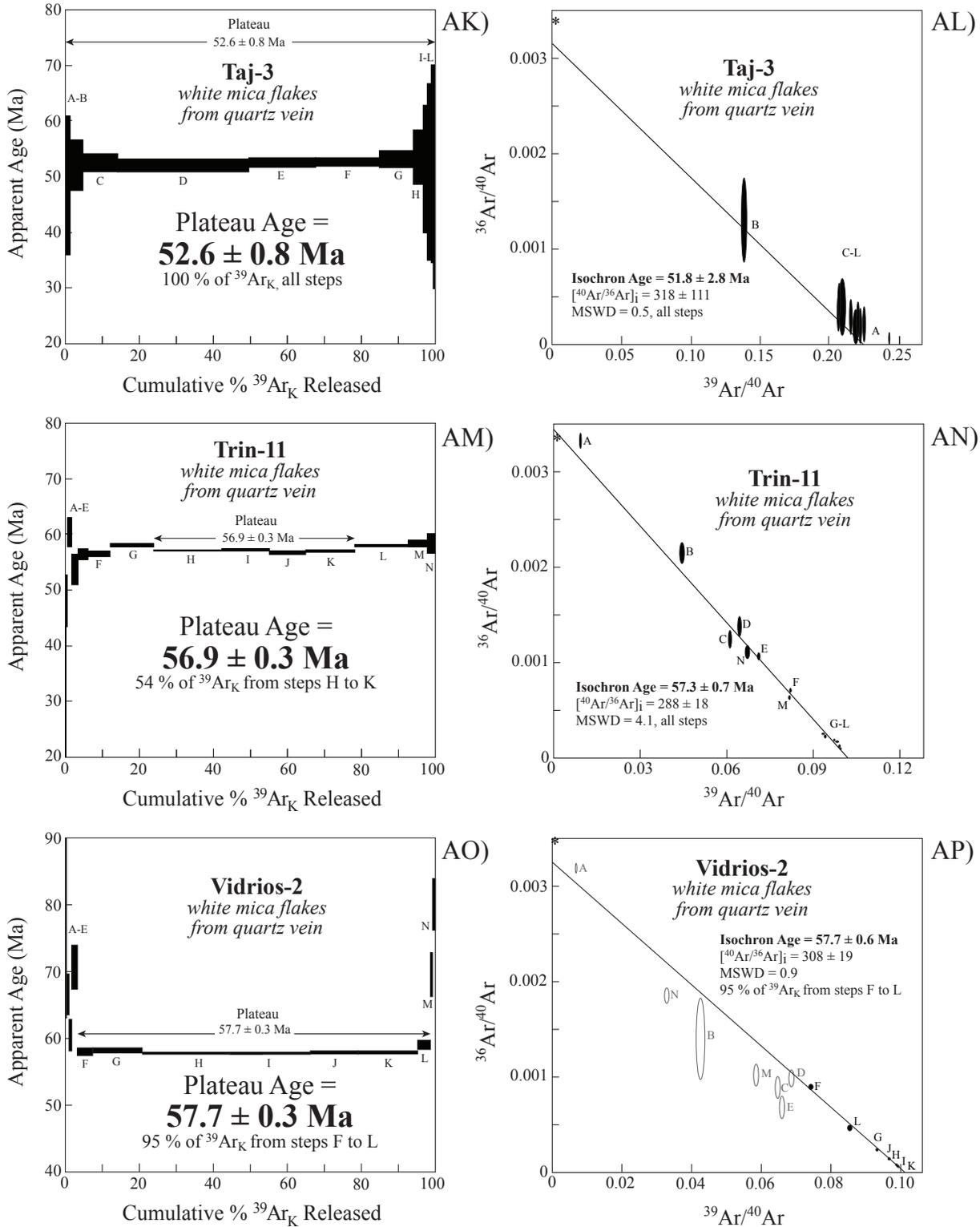
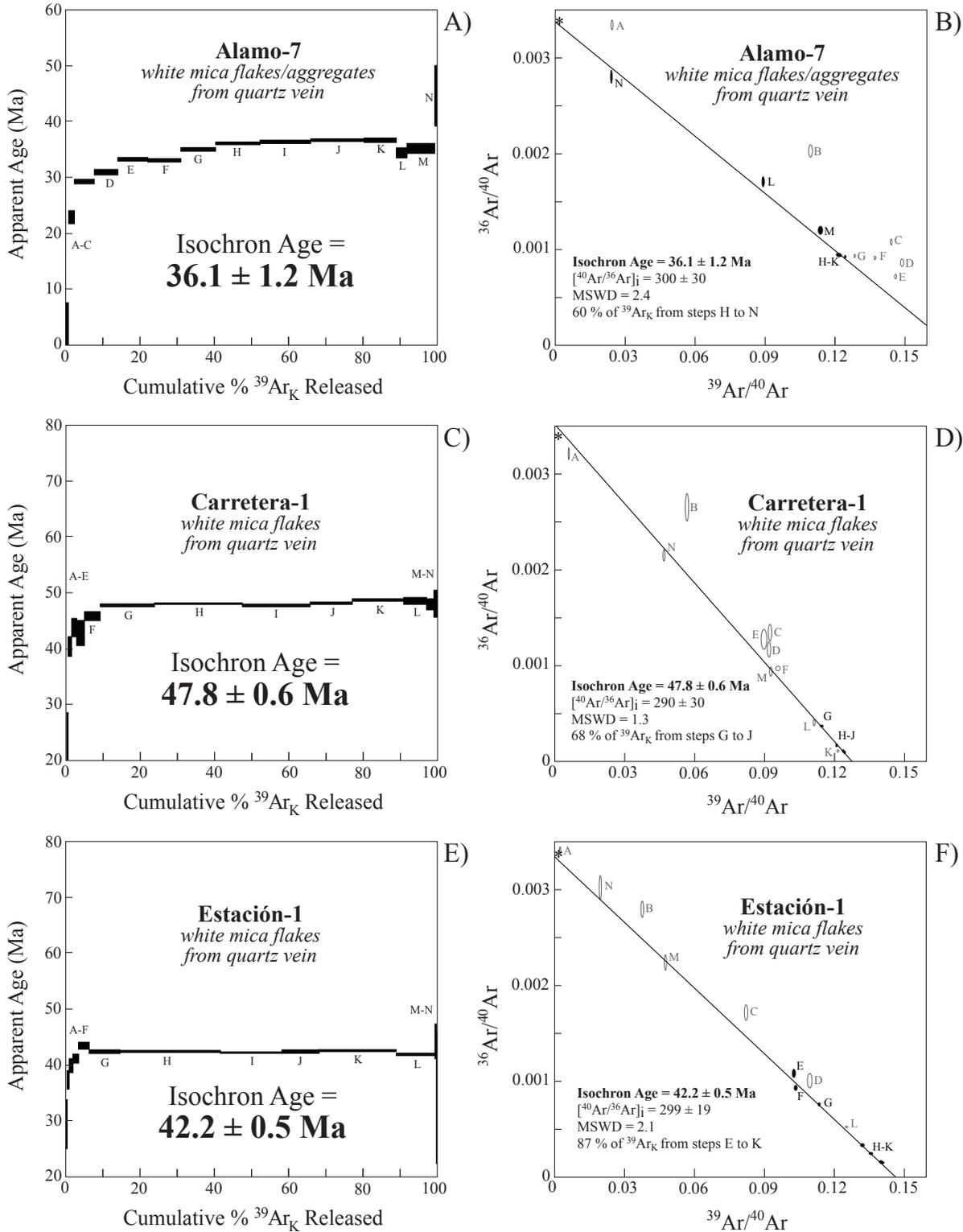


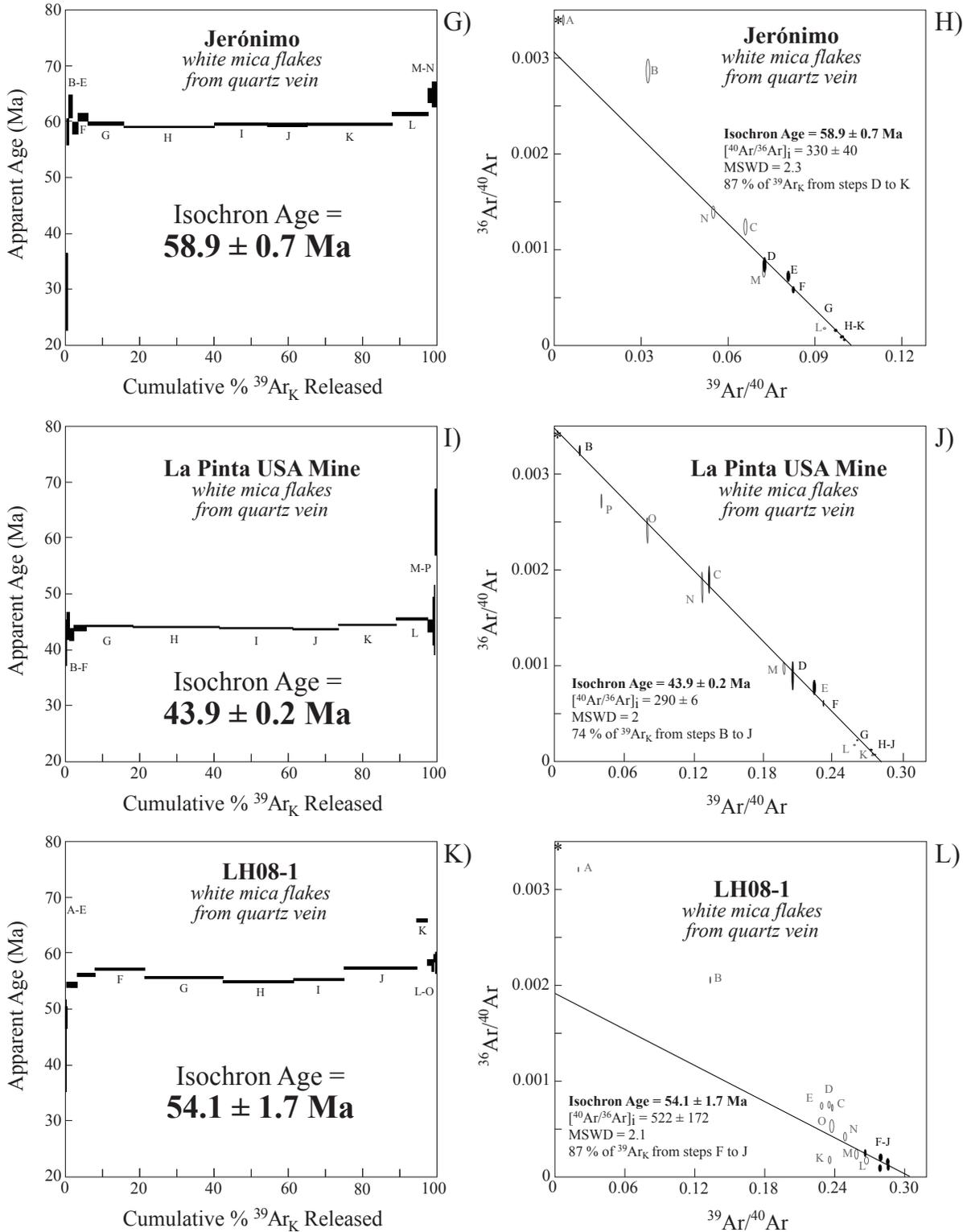
Figure 3—Continued. Age spectrum (AE, AG, AI) and inverse-isotope correlation diagrams (AF, AH, AJ) from group 1 of white mica samples of gold-rich quartz veins, with plateau age as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 3—Continued.** Age spectrum (AK, AM, AO) and inverse-isotope correlation diagrams (AL, AN, AP) from group 1 of white mica samples of gold-rich quartz veins, with plateau age as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 4.** Age spectra (A, C, E) and inverse-isotope correlation diagrams (B, D, F) from group 2 of white mica samples of gold-rich quartz veins, with isochron ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio. Abbreviations: Ma, mega-annum; MSWD, mean square weighted deviation.



**Figure 4—Continued.** Age spectra (G, I, K) and inverse-isotope correlation diagrams (H, J, L) from group 2 of white mica samples of gold-rich quartz veins, with isochron ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

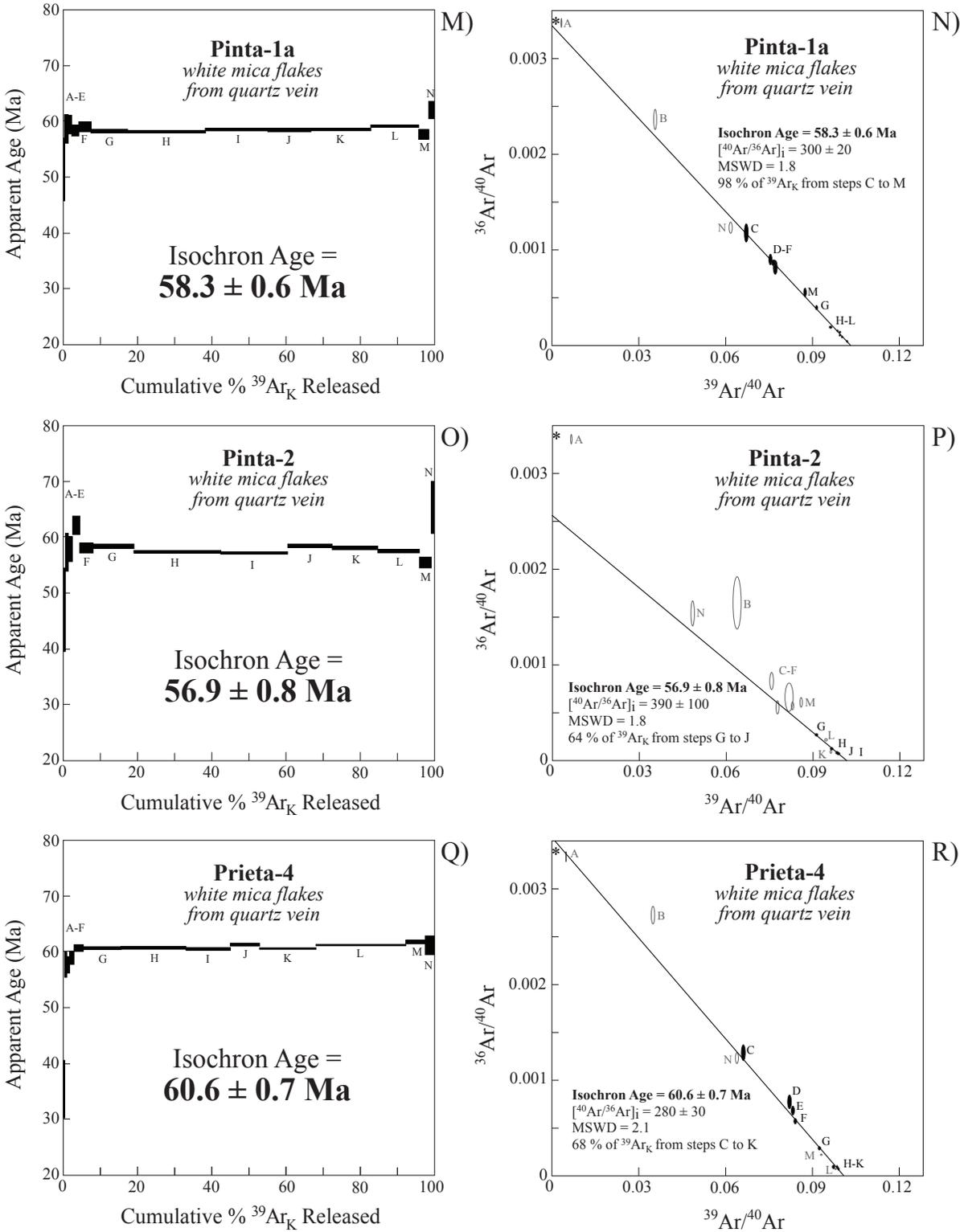
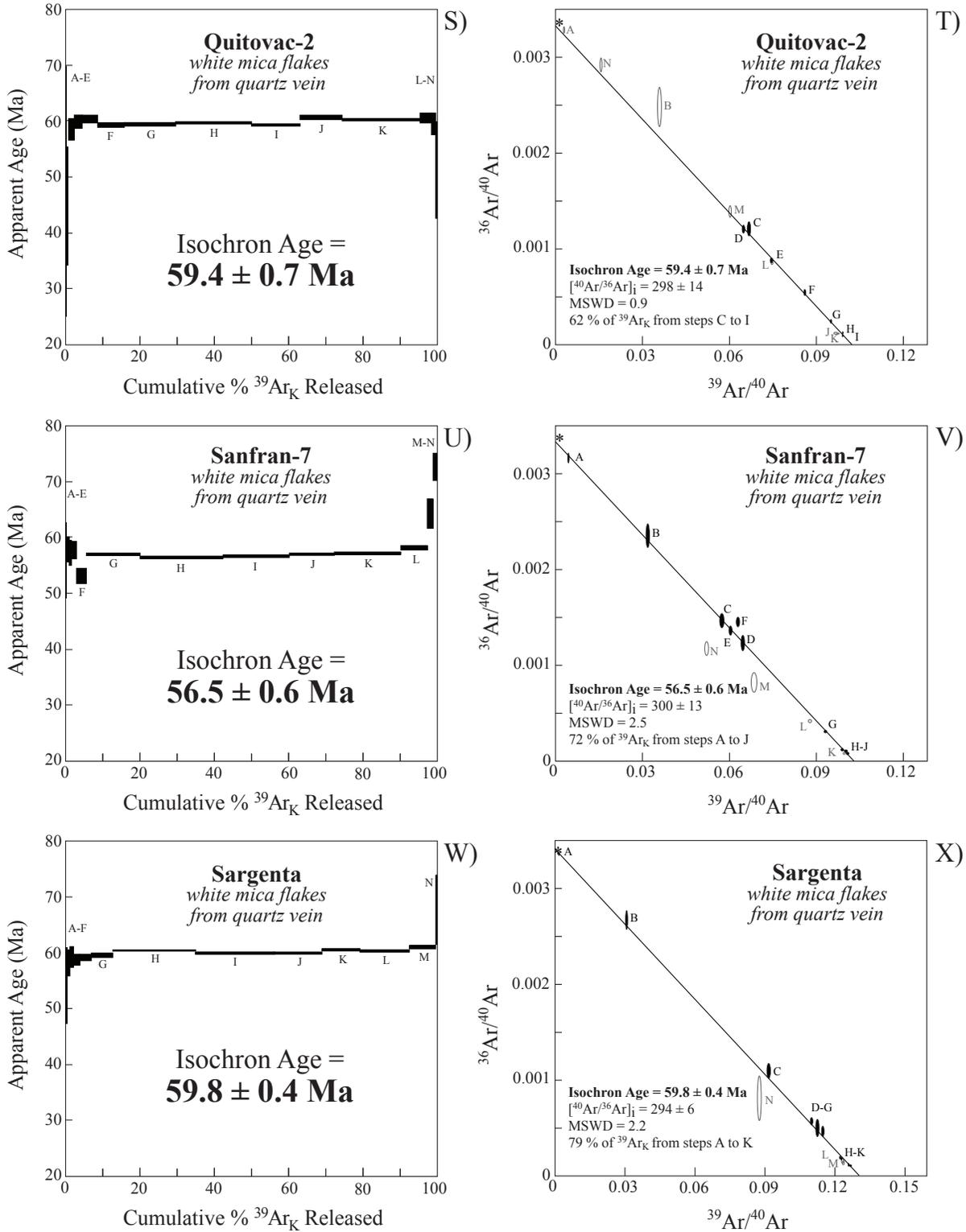


Figure 4—Continued. Age spectra (M, O, Q) and inverse-isotope correlation diagrams (N, P, R) from group 2 of white mica samples of gold-rich quartz veins, with isochron ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



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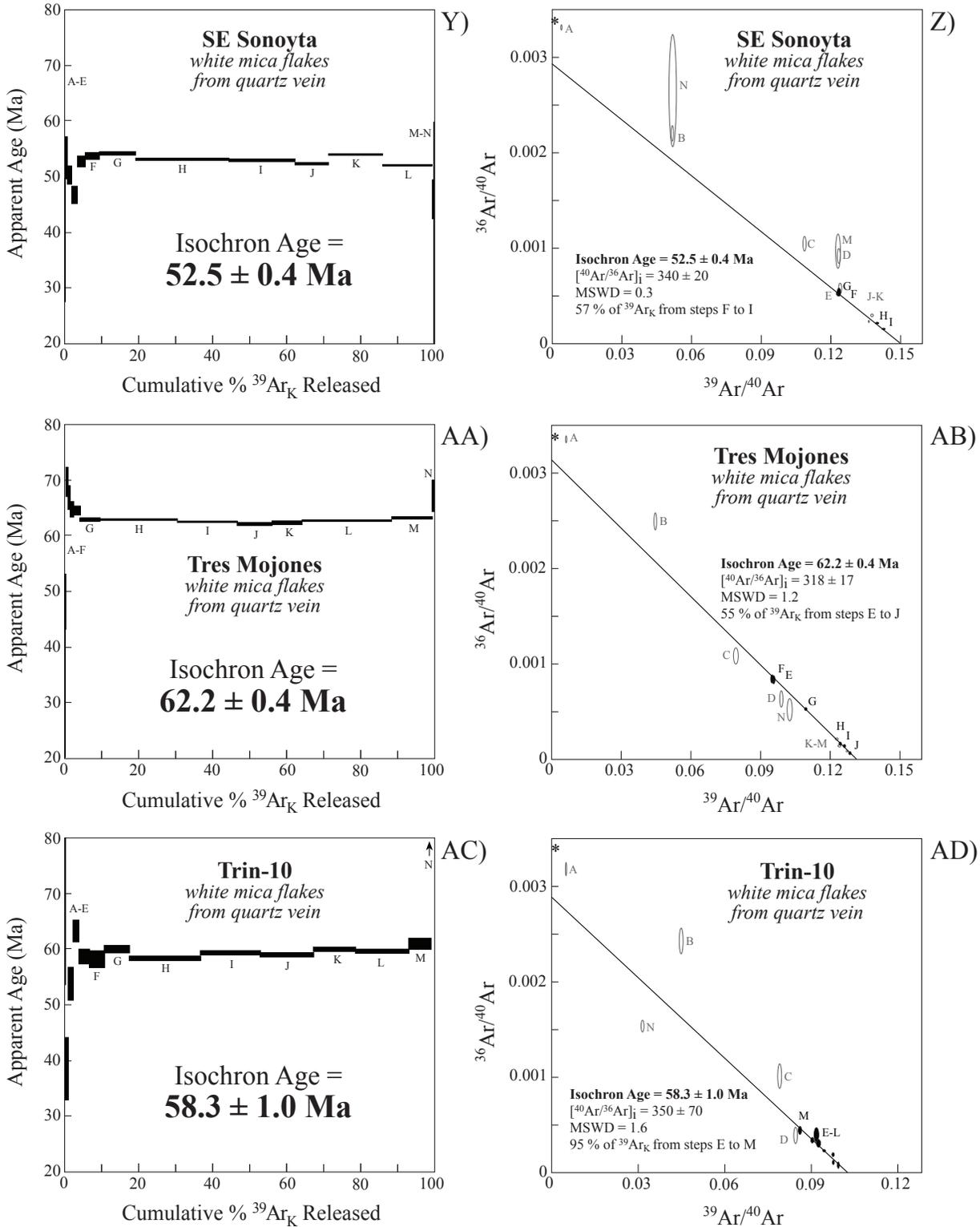
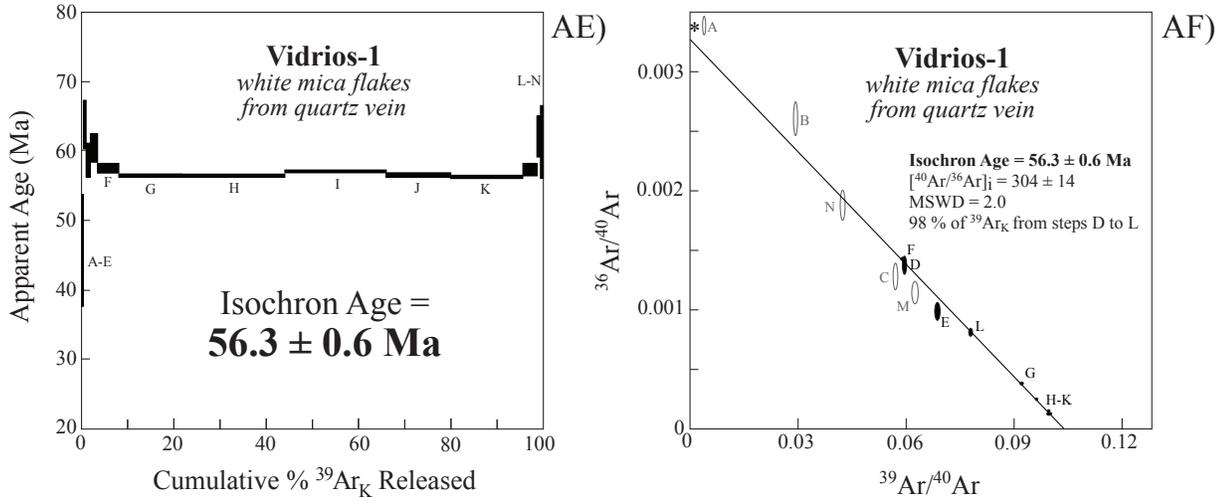
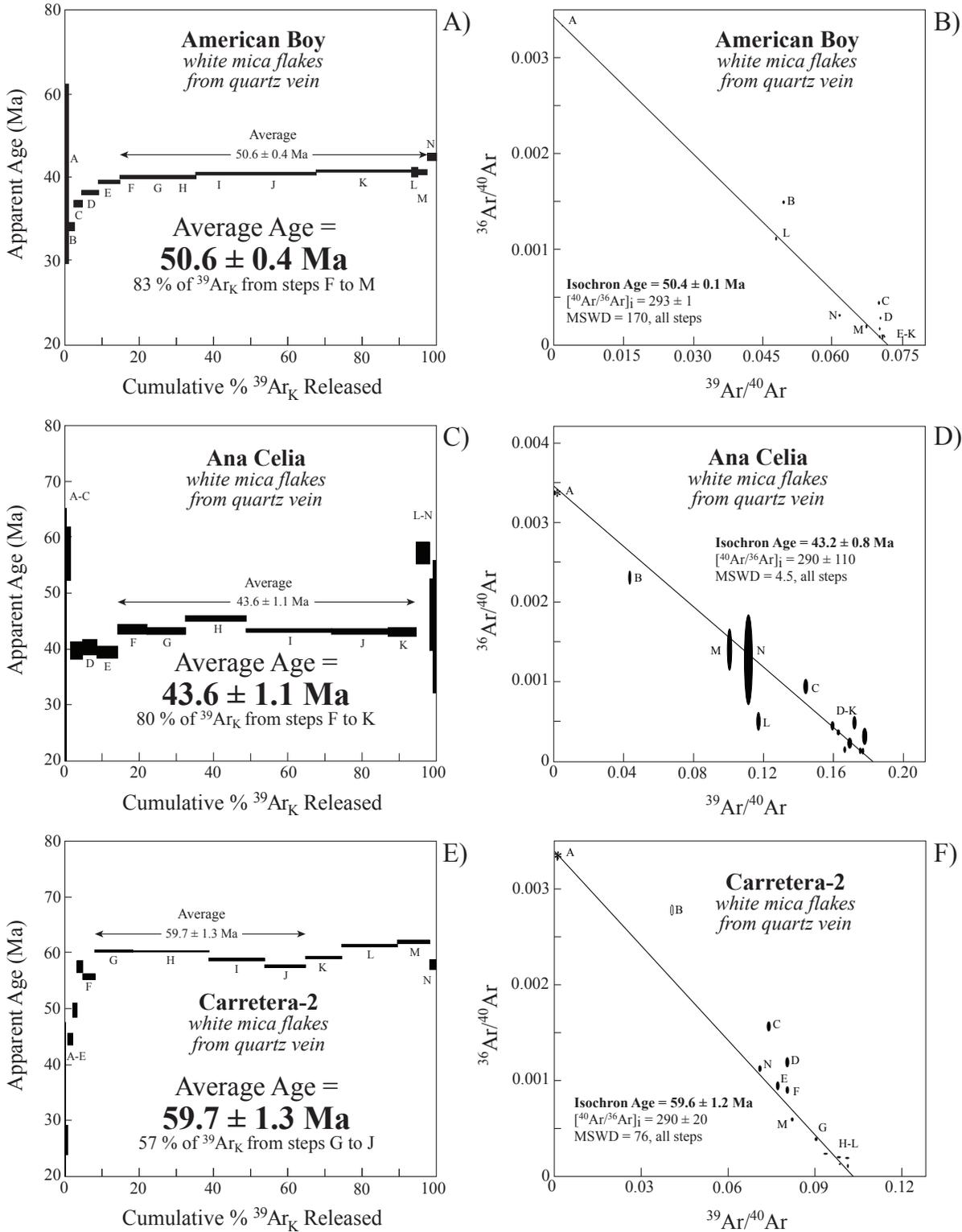


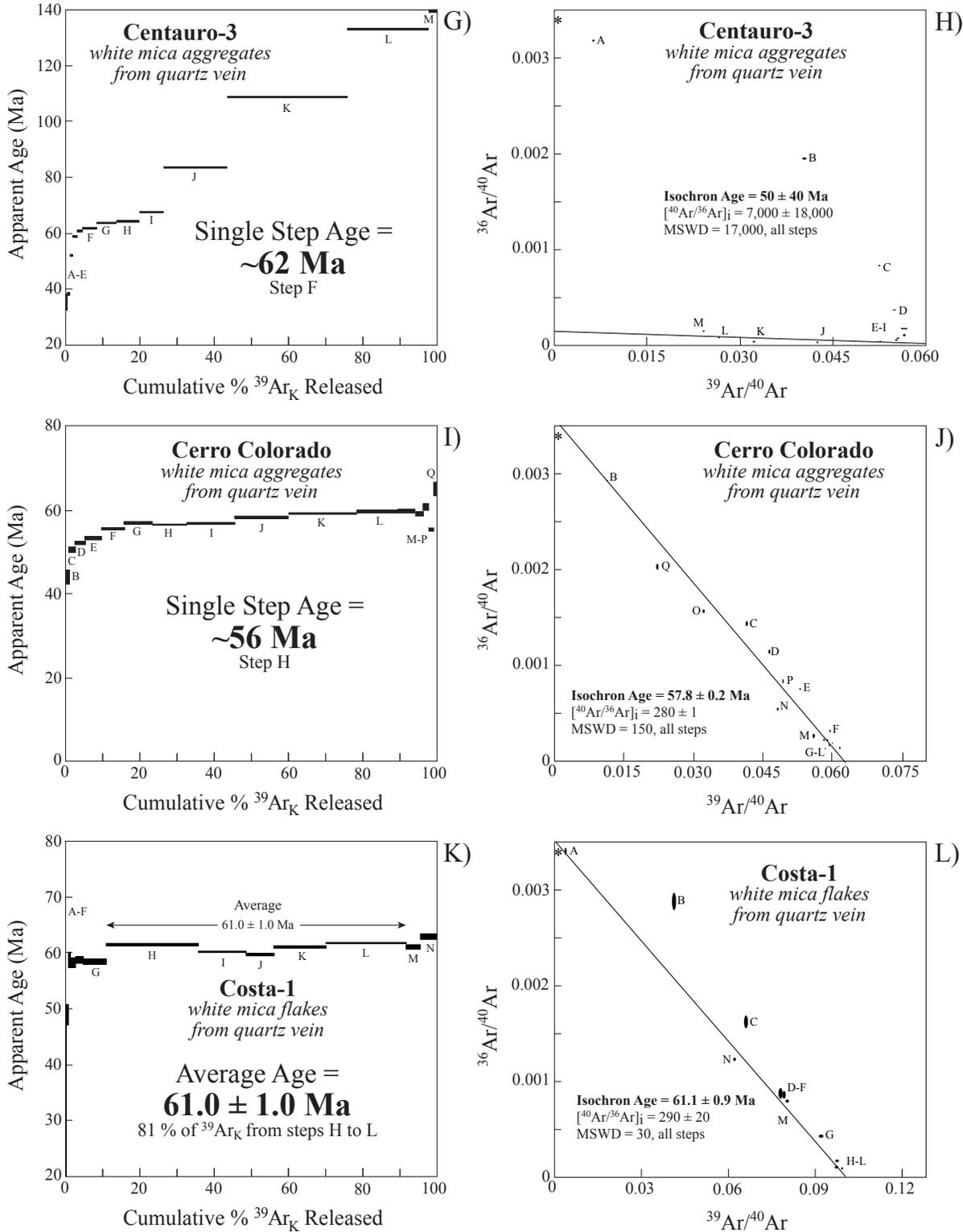
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**Figure 4—Continued.** Age spectra (AE) and inverse-isotope correlation diagrams (AF) from group 2 of white mica samples of gold-rich quartz veins, with isochron ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 5.** Age spectra (A, C, E) and inverse-isotope correlation diagrams (B, D, F) from group 3 of white mica samples of gold-rich quartz veins, with average ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio. Abbreviations: Ma, mega-annum; MSWD, mean square weighted deviation.



**Figure 5—Continued.** Age spectra (G, I, K) and inverse-isotope correlation diagrams (H, J, L) from group 3 of white mica samples of gold-rich quartz veins, with average and single-step ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

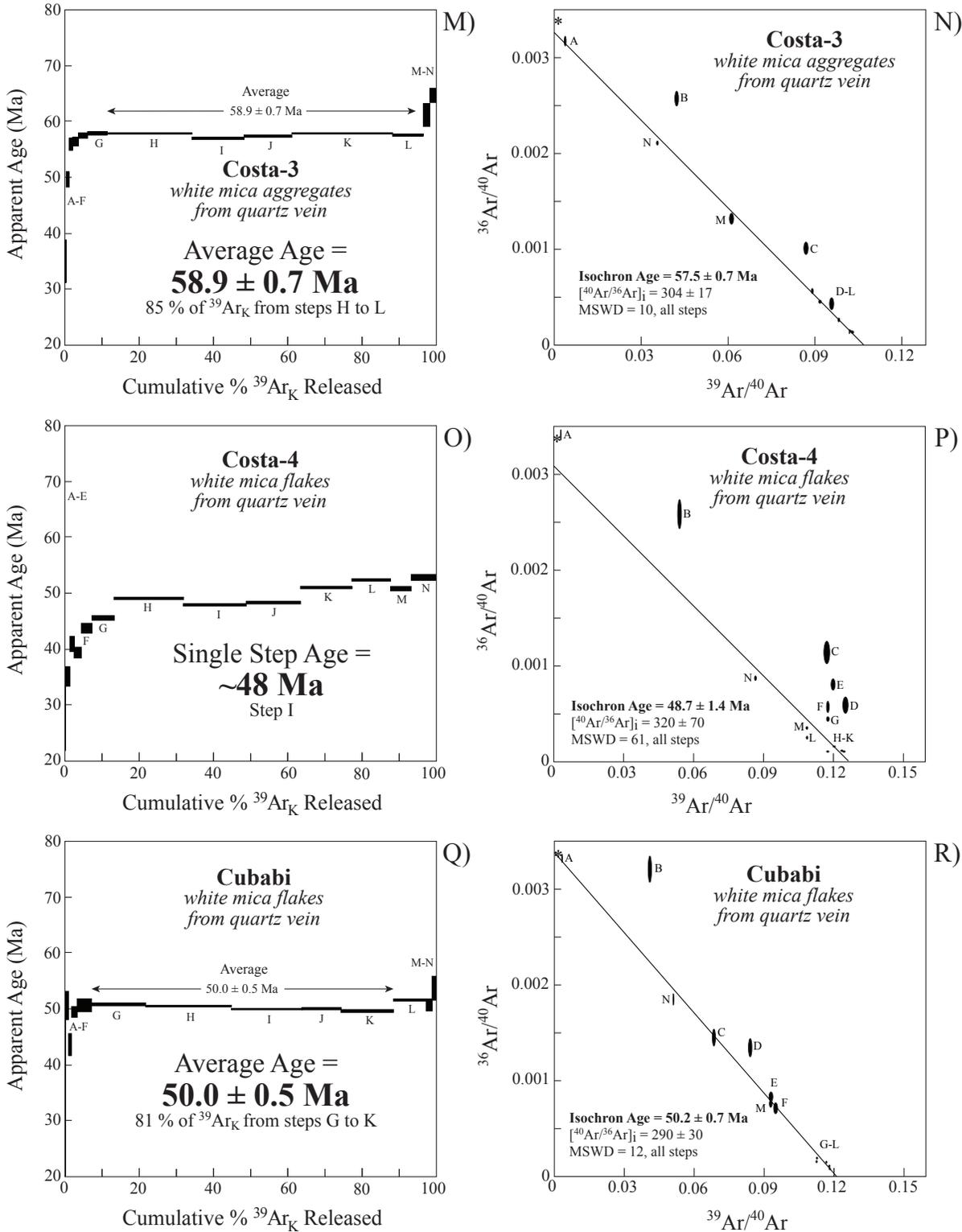
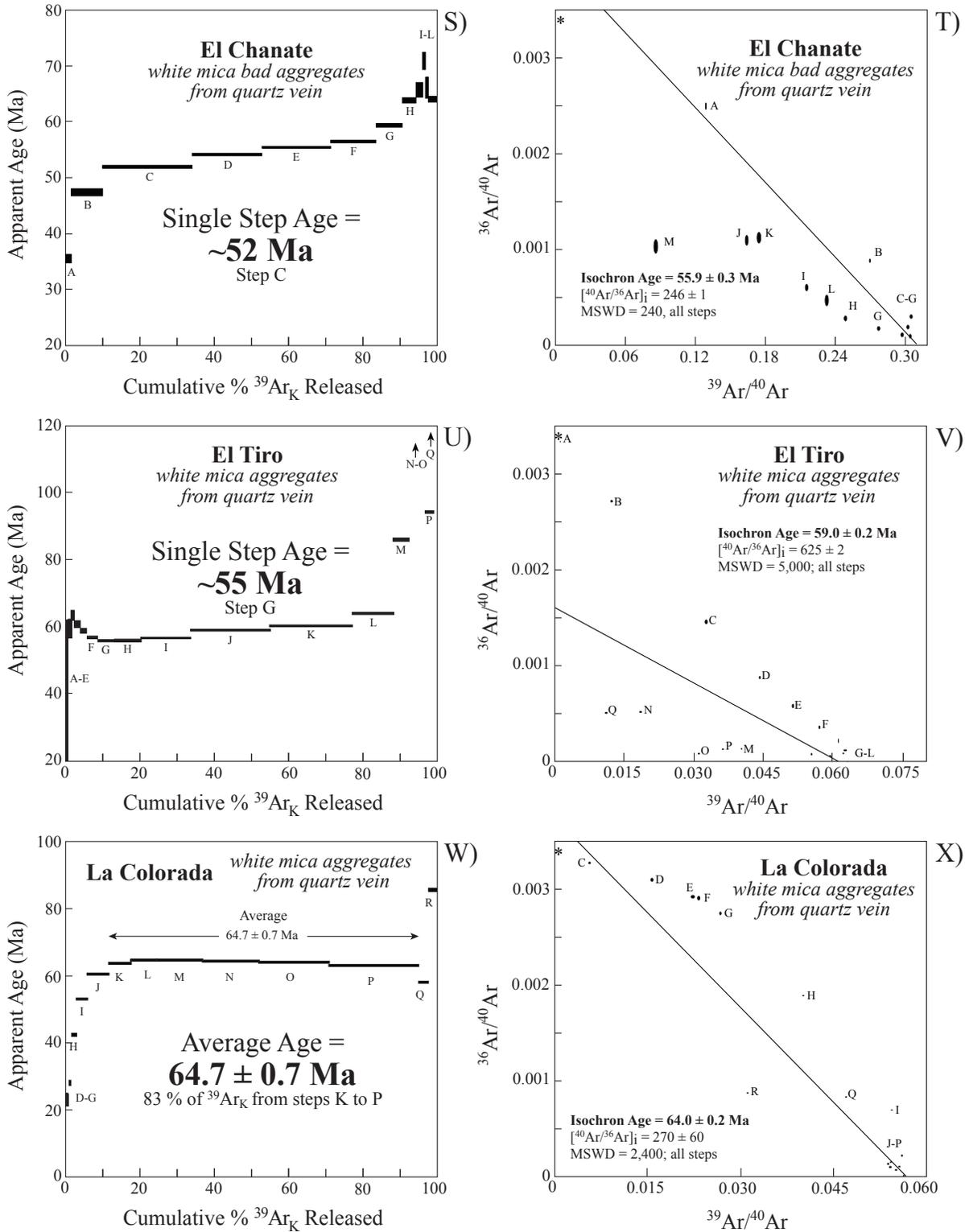


Figure 5—Continued. Age spectra (M, O, Q) and inverse-isotope correlation diagrams (N, P, R) from group 3 of white mica samples of gold-rich quartz veins, with average and single-step ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 5—Continued.** Age spectra (S, U, W) and inverse-isotope correlation diagrams (T, V, X) from group 3 of white mica samples of gold-rich quartz veins, with average and single-step ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

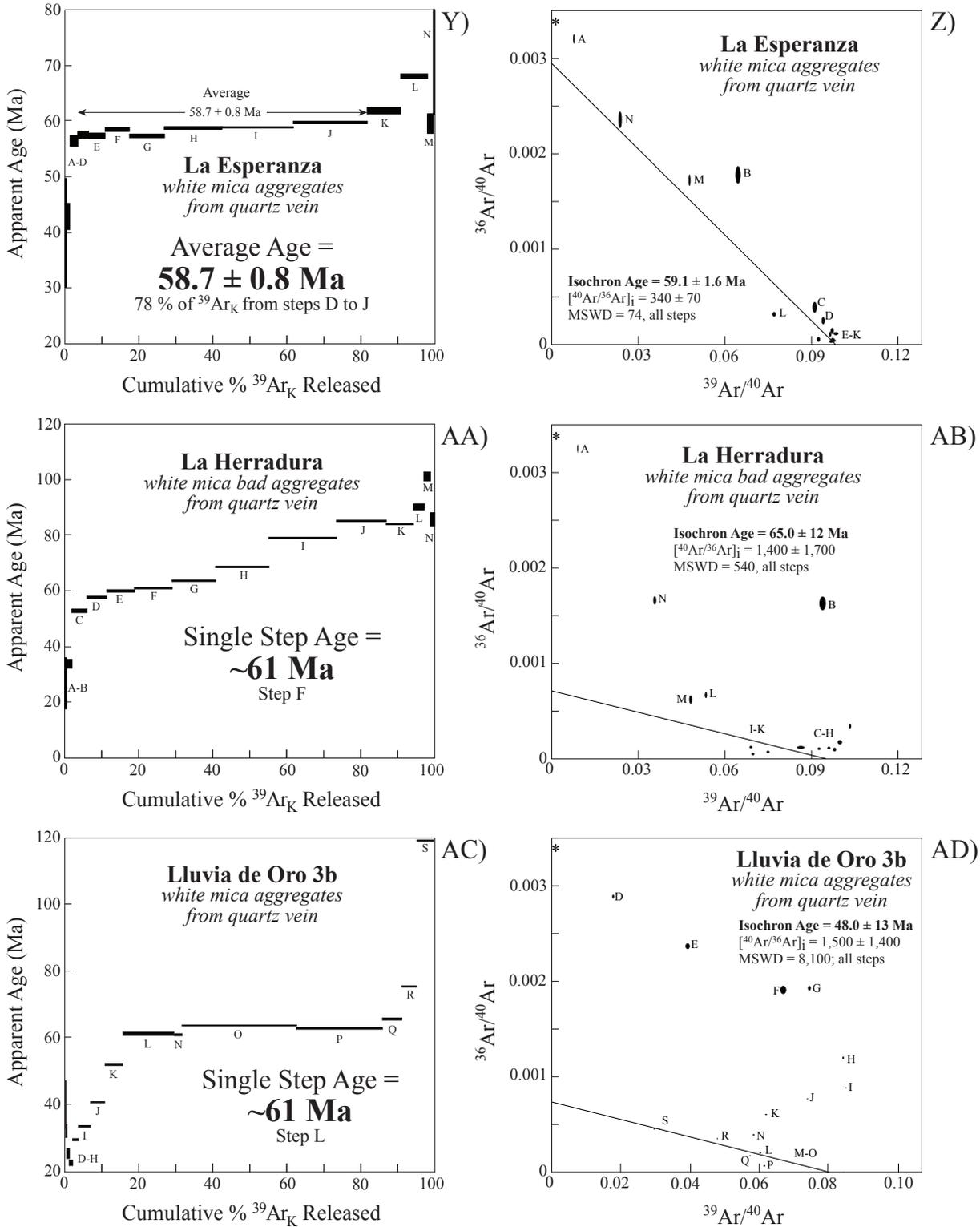
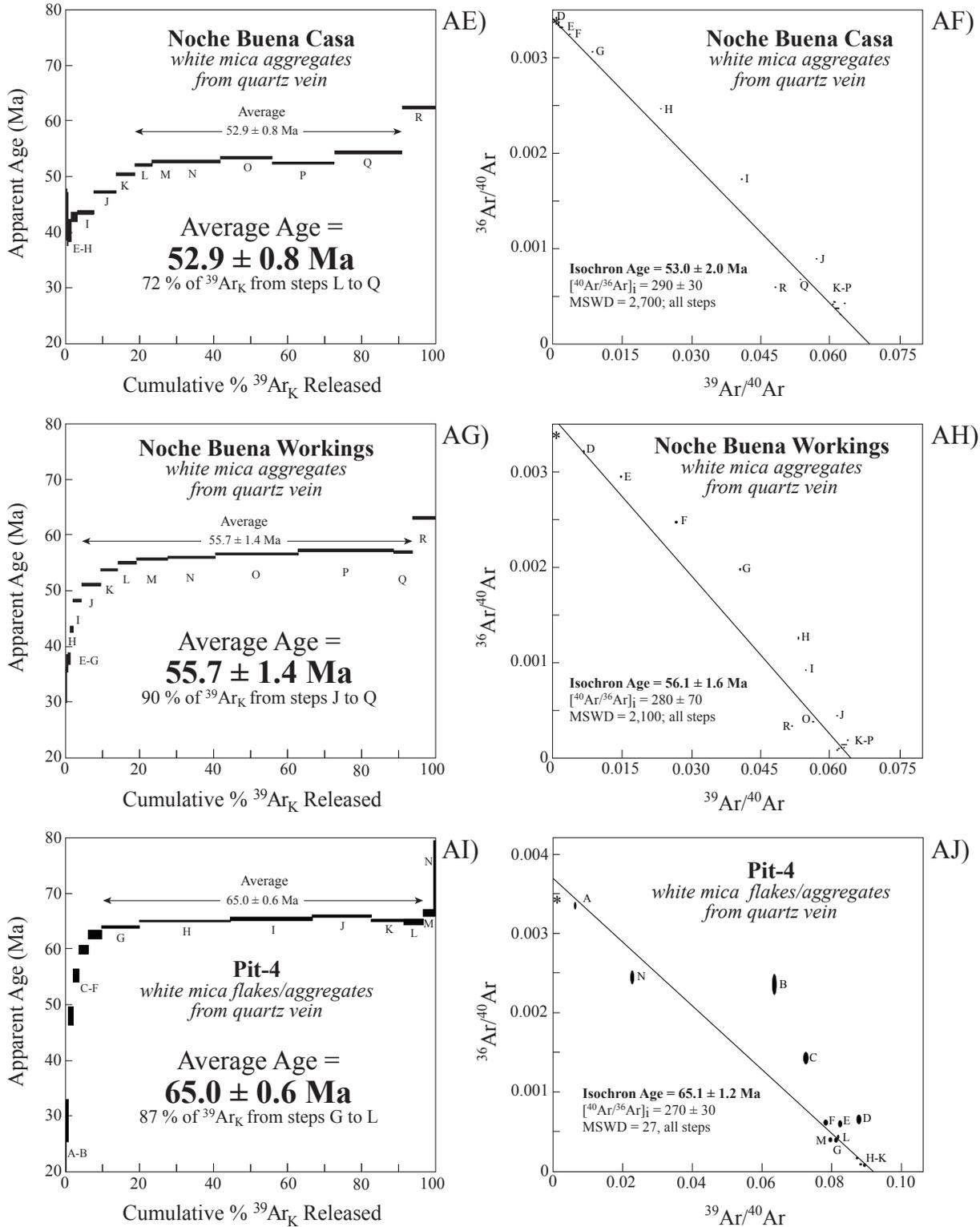


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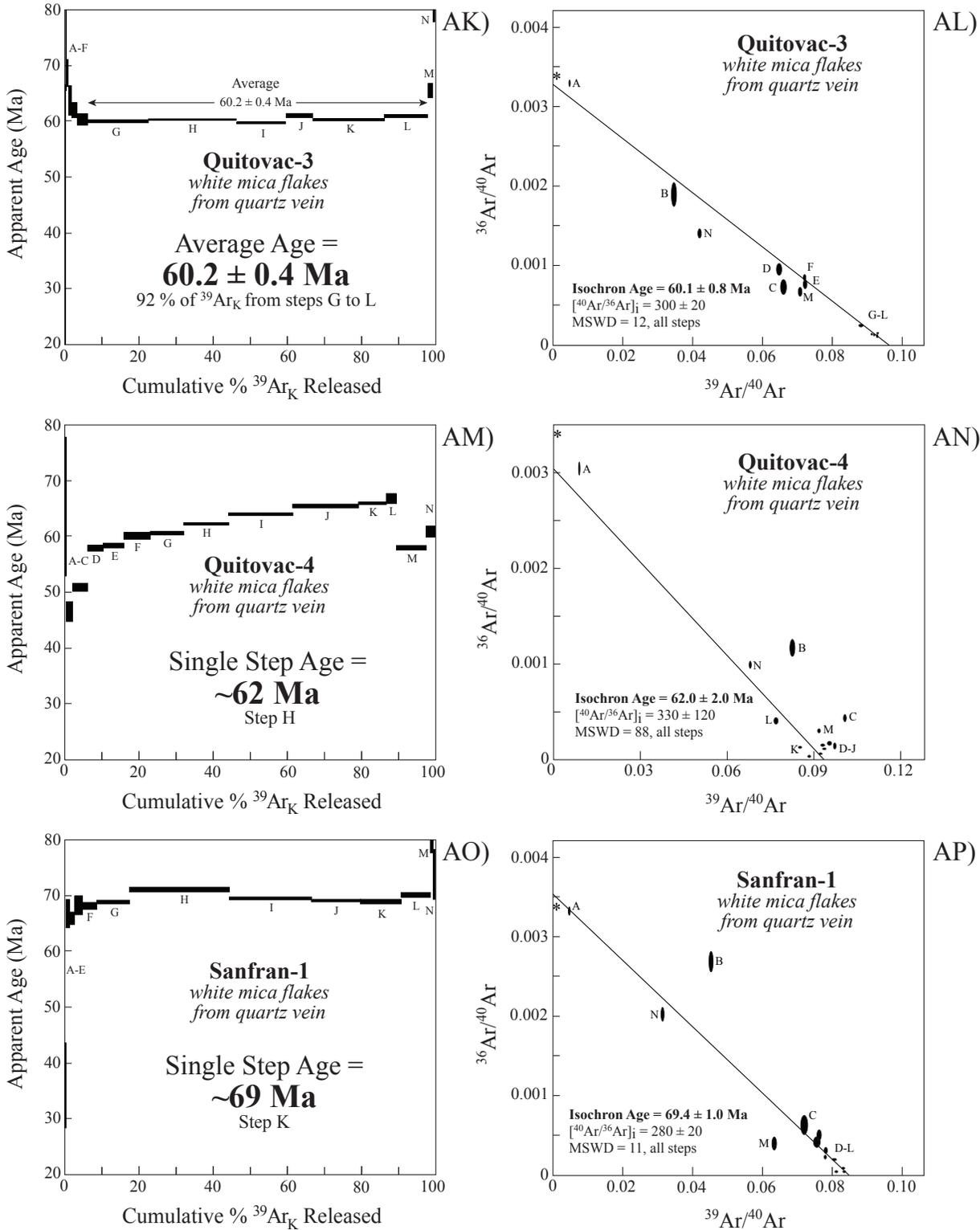
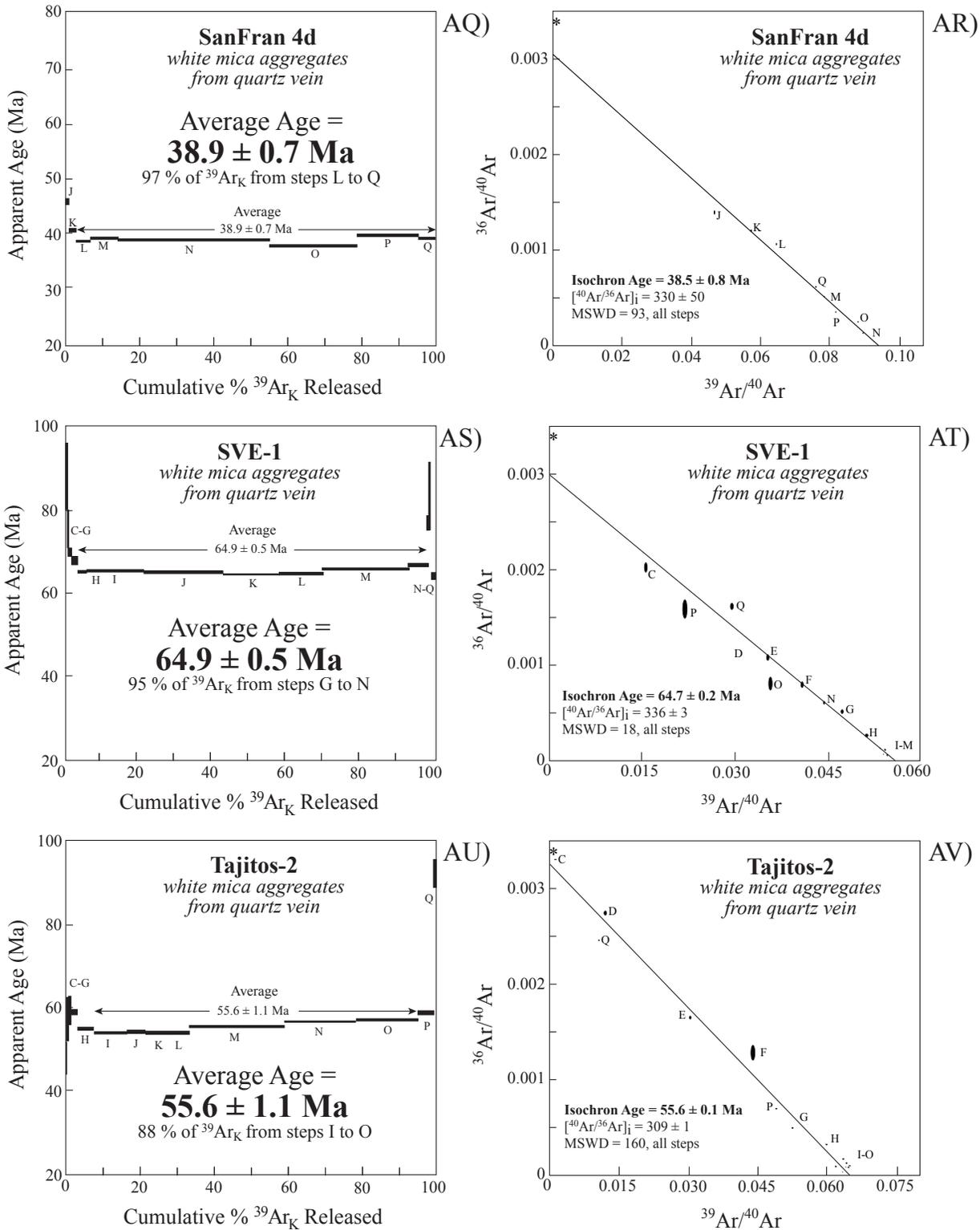


Figure 5—Continued. Age spectra (AK, AM, AO) and inverse-isotope correlation diagrams (AL, AN, AP) from group 3 of white mica samples of gold-rich quartz veins, with average and single-step ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



**Figure 5—Continued.** Age spectra (AQ, AS, AU) and inverse-isotope correlation diagrams (AR, AT, AV) from group 3 of white mica samples of gold-rich quartz veins, with average ages as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.

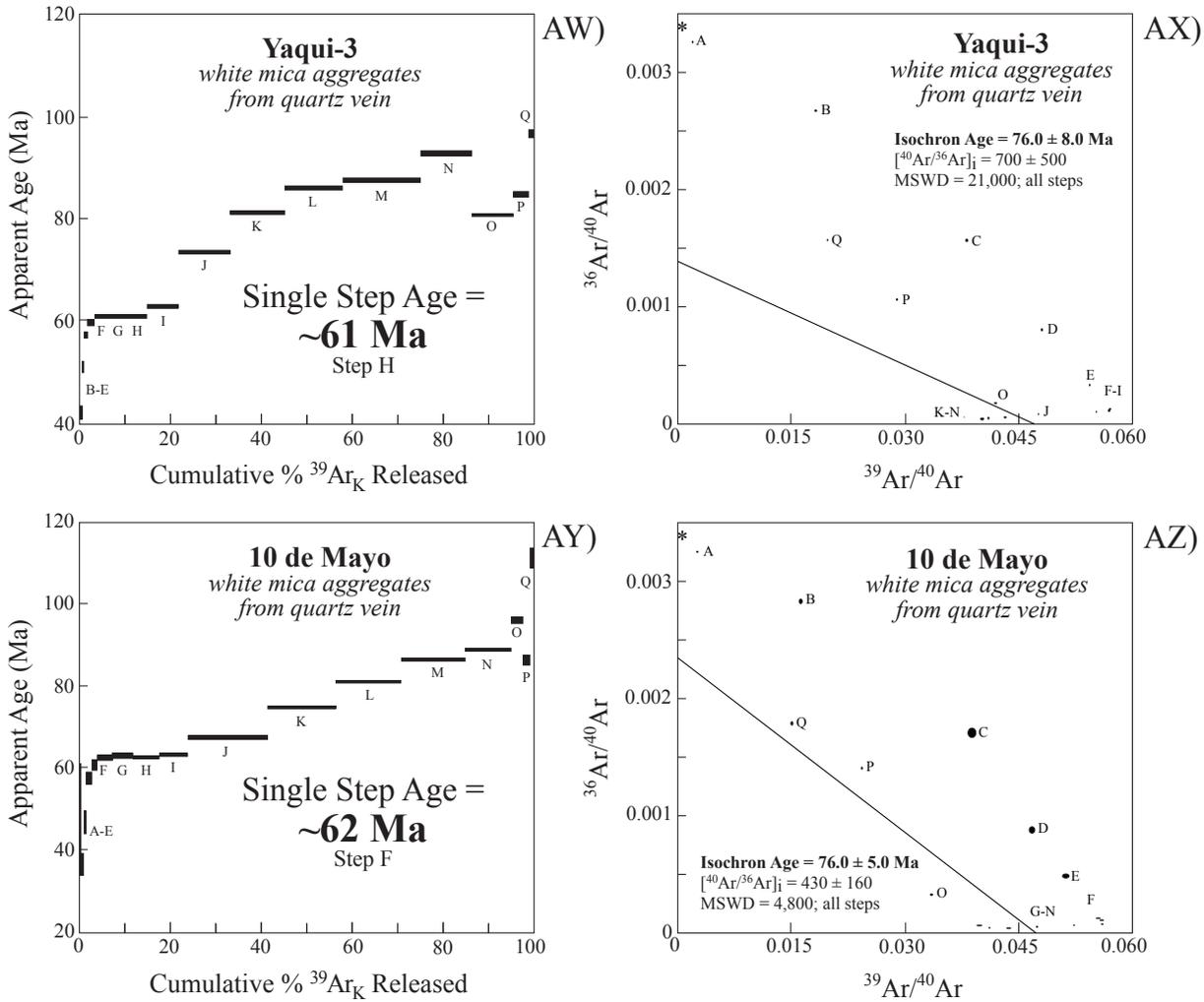


Figure 5—Continued. Age spectrum (AW, AY) and inverse-isotope correlation diagram (AX, AZ) from group 3 of white mica samples of gold-rich quartz veins, with single-step age as best age, from the Caborca orogenic gold belt (COGB), northwestern Sonora, Mexico. \* is the assumed limit of the atmospheric argon ratio.



