The Coupled Velocity-Hypocenters method obtained the location of the hypocenter and the 1-D velocity model of the P waves of the study area, as shown in Fig. 14. Meanwhile, the location test's RMS error value using the Coupled Velocity-Hypocenters method was better than the Geiger method. RMS error values varied from 0.05 seconds to 0.75 seconds, with an average RMS error of 0.19 seconds as in Fig. 15.

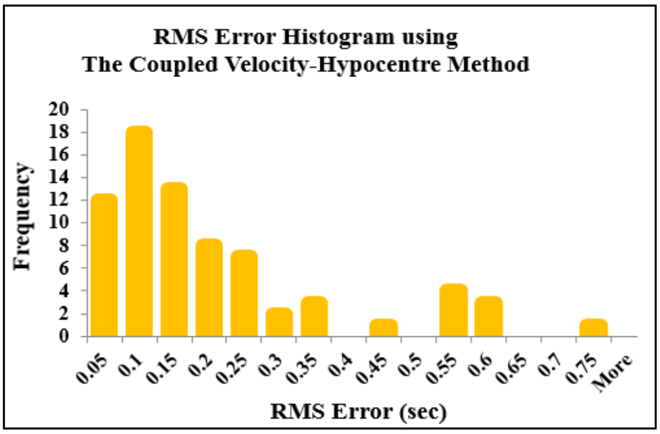

Fig. 15 RMS error histogram of micro-earthquake hypocenter determined using the Coupled Velocity-Hypocenters method

The result indicates that microearthquake hypocenter around X geothermal area happened due to reservoir activity in the production well or around the heat source area. The fluid activity is flowing through the fracture from the permeable zone in the heat source area, indicating the contact between cold water with high-temperature igneous rocks (heat source). The control of these two methods complies with the study area's conditions and the minimum error value (RMS error). RMS error is the residual or the difference between the recording time and the calculation time. The smaller the RMS error (near zero), the better.

IV. Conclusion

The distribution of micro-earthquake hypocenter around the X geothermal area using Coupled Velocity-Hypocenter (with several corrected parameters such as 1-D of P waves velocity model, origin time, micro-earthquake hypocenter coordinates, station correction) provides a better result compared to Geiger method. This result is supported by the Coupled Velocity-Hypocenters method's average RMS error value, which was smaller, only 0.19 seconds, compared to the Geiger method, which had an average RMS error of 0.74 seconds. The micro-earthquake hypocenter location of the location test results using the Coupled Velocity-Hypocenters method was more concentrated in the reservoir area in the production well which indicates the presence of fluid flow through the fracture of the permeable zone. The micro-earthquake hypocenter location was also concentrated in the heat source area, which was suspected to occur due to cold water contact with temperature igneous rocks height (heat source) on the X geothermal area.

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